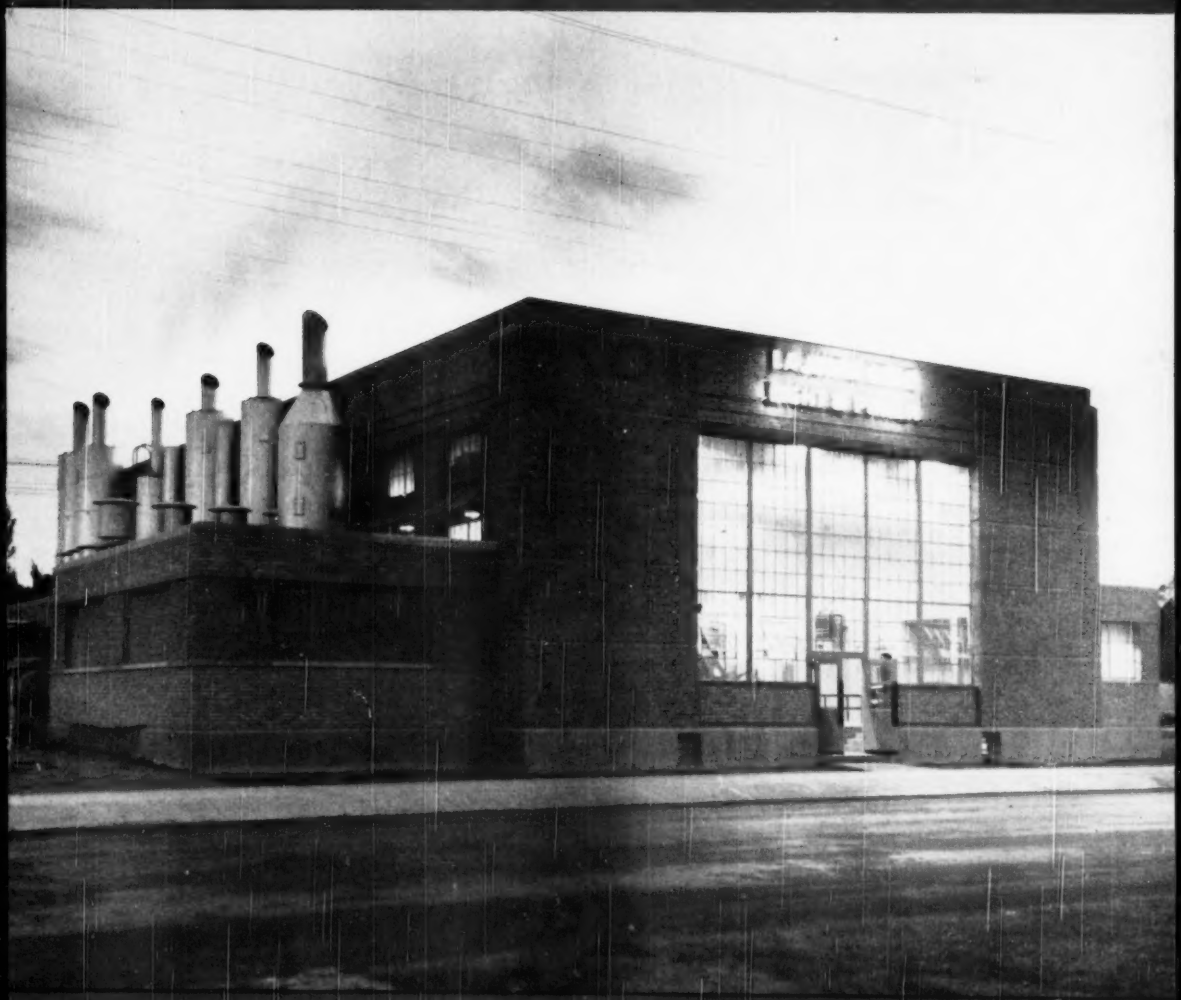
Diesel Power

& Diesel Transportation



Our 28th Year

MAY, 1950

DIESELS RUN

and fuel costs are less when you lubricate with Texaco Ursa Oils

ANY Diesel lubricated with *Texaco Ursa Oil* is bound to run cleaner because *Texaco Ursa Oils* have high resistance to oxidation . . . and are designed to keep harmful carbon, sludge and varnish from forming. So rings stay free, valves work the way they should, ports stay open . . . assuring better compression and combustion.

In addition, *Texaco Ursa Oils* maintain their tough lubricating films in spite of heat and high pressure. Wear all but vanishes. Bearings and all moving parts last longer. No wonder maintenance costs and fuel consumption are less when *Texaco Ursa Oils* are on the job!

There is a complete line of *Texaco Ursa Oils*. They are approved by leading Diesel manufacturers, and are easily America's favorite Diesel lubricants — as shown by the fact that *more stationary Diesel h.p. in the U. S. is lubricated with Texaco Ursa Oils than with any other brand.*

Get a greater return from your Diesel operating dollar. A Texaco Lubrication Engineer will gladly help you. Just call the nearest of the more than 2,000 Texaco Wholesale Distributing Plants in the 48 States, or write The Texas Company, 135 East 42nd Street, New York 17, N. Y.

TUNE IN . . .
TEXACO STAR THEATER
starring
MILTON BERLE
on television
every Tuesday night.
See newspaper for
time and station.

TEXACO

TEXACO

DIESEL POWER and DIESEL TRANSPORTATION for May, 1950, Vol. XXVIII, No. 5. It is published monthly by Diesel Publications, Inc., Orange, Conn. Executive and Editorial offices 192 Lexington Ave., New York 16, N. Y. Subscription rates: United States, $3.00 per year; single copies, 30¢. Canada, $4.00. Foreign, $5.00 per year. Entered as second class matter April 29, 1949 at the Post Office, Orange, Connecticut, under Act of March 3, 1879.

CLEANER...

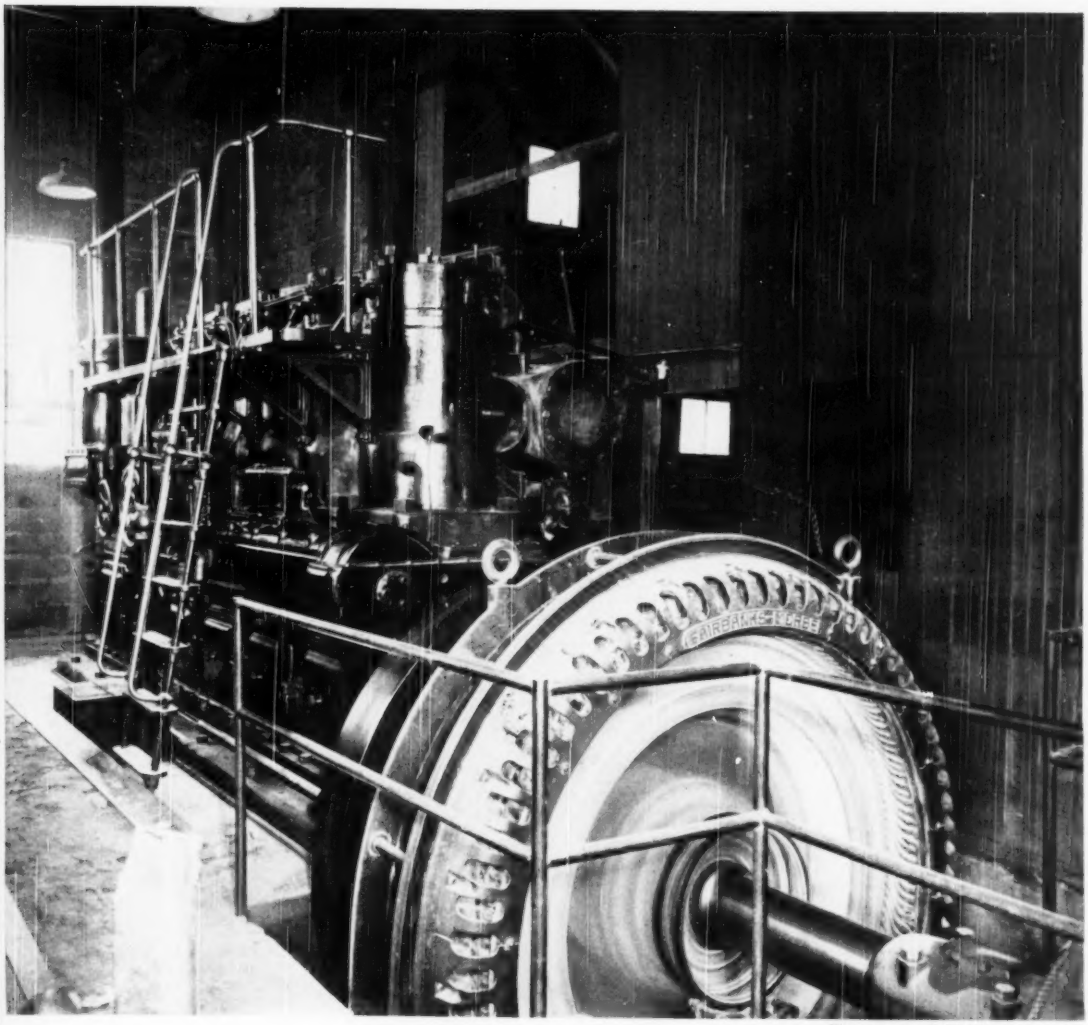


Photo courtesy Fairbanks, Morse & Co.

URSA OILS

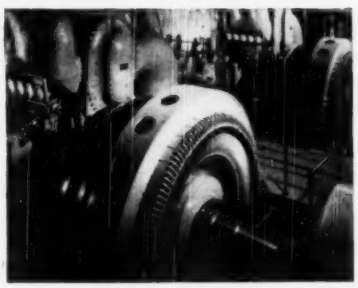
FOR ALL DIESEL ENGINES

AT YOUR SERVICE: *50 years*

High-quality generators at minimum cost . . . the natural result of 50 years of G-E generator-building experience

Quality that gives you the most for your generator dollar is the natural result of more than half a century of generator building . . . the result of skills developed by men like Charles Wahl.

A machinist for more than 40 years, Mr. Wahl learned his high standard of workmanship from men like his father, also a master machinist. Today he's passing his tradition of craftsmanship along to younger men . . . teaching them to build G-E quality into electric equipment. We're proud of Charles Wahl, and Mr. Wahl is proud to help us give you the service that's your right as a G-E customer.



Dependability and high operating efficiency are characteristic of every G-E synchronous generator . . . the result of more than 50 years' experience in development, manufacture, and application of synchronous generators. Performance records of thousands of these sturdy, efficient generators now on the job have made G.E. a "buy" word for purchasers of power-generation equipment. Apparatus Department, General Electric Co., Schenectady 5, N. Y.

Your Best Generator Buy...

# of know-how

GENERAL ELECTRIC

770-16

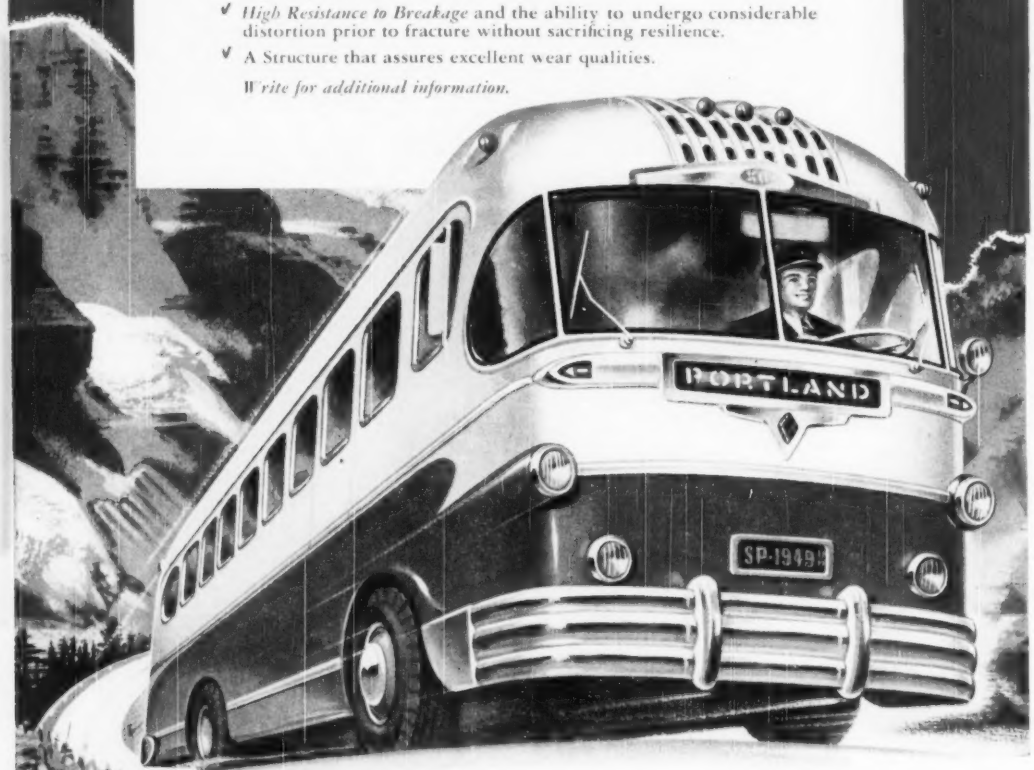
Announcing a New Piston Ring Material

"CYCLAN"

Especially developed for severe service in high duty diesel and gas engines. This superior material has the following necessary qualifications of a good piston ring alloy!

- En Value higher than 20,000,000.
- *Tensile Strength* in excess of 60,000 P. S. I.
- *Extreme Resistance* to Property Changes under operating conditions.
- *High Impact Value* for shock resistance.
- *High Resistance to Breakage* and the ability to undergo considerable distortion prior to fracture without sacrificing resilience.
- A Structure that assures excellent wear qualities.

Write for additional information.



SEALED POWER CORPORATION
MUSKEGON, MICHIGAN

Sealed Power

PISTON RINGS · PISTONS
CYLINDER SLEEVES

NEW KICK IN THE OLD "MULE"

"Sheryl L" has two 6-cylinder GM Diesels driving twin 44" x 36" propellers through 4.5 to 1 reduction gears. Each engine is equipped with GM hydraulically operated reverse gears.

A FORMER U. S. Navy Sea Mule, the "Sheryl L", has been successfully converted to a river tow boat by Luhr Brothers, river contractors of Columbia, Illinois.

Sporting a pair of 6-cylinder GM Series 71 Diesel engines in place of the original power plants, "Sheryl L" attains speeds of 5 MPH upstream and 12 MPH downstream. She pushes a 38' x 120' barge, loaded with heavy equipment and supplies on the Mississippi and Missouri Rivers.

GM Diesels were a natural choice for this job because 2-cycle operation—power at every downstroke—makes them more powerful, more compact, easier to start and more responsive when maneuvering.

Whatever your need for power, you'll find it profitable to standardize on General Motors Diesels. Not only are they frugal with fuel, but these engines are long-lived, durable workers that are easy to maintain. See your local distributor, or write directly for further details.

DETROIT DIESEL ENGINE DIVISION

SINGLE ENGINES... Up to 200 H. P. **DETROIT 28, MICHIGAN** MULTIPLE UNITS... Up to 800 H. P.

GENERAL MOTORS

GM GENERAL MOTORS DIESEL POWER

DIESEL BRAWN WITHOUT THE BULK

Late Type
High Grade
Heavy Duty

MACHINE TOOLS, PRECISION TOOL ROOM EQUIPMENT, PRODUCTION MACHINERY, FOUNDRY EQUIPMENT, CRANES & SHOP EQUIPMENT

of the

FULTON IRON WORKS COMPANY

1259 DELAWARE AVE., WELLSTON — a suburb of

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TO BE SOLD BY ORDER OF THE BOARD OF DIRECTORS at

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Starting at 10:30 A.M. Each Day
Everything Will Be Sold Piece by Piece
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CINCINNATI HYPRO 120" X 96" X 34" DOUBLE HOUSING PLANER; CINCINNATI HYPRO 72" X 72" X 34" OPEN SIDE PLANER; CINCINNATI HYPRO 10' VERTICAL BORING MILL; 6 GIDDINGS & LEWIS NO. 560F AND NO. 45—4½" AND 6" BORING BARS; SELLERS 5" BORING BAR; NILES 6" BORING BAR; BARRETT 7" BORING BAR; LUCAS 3" BORING BAR; 8 GRAY, NILES AND BETTS 120", 60", 48", 43" AND 42" DOUBLE HOUSING PLANERS; 7 LODGE AND SHIPLEY, AMERICAN, PUTNAM, NILES AND BRIDGEPORT 24", 36", 42", 48", 54", AND 60" GEARED HEAD AND PLAIN ENGINE LATHES; NEWTON ROTARY PLANER; 2 FULTON 500 TON AND 1500 TON HYDRAULIC PRESSES; 7 CINCINNATI-BICKFORD SUPER SERVICE AND AMERICAN HOLE WIZARD 3', 6', AND 7' RADIAL DRILLS; 15 AMERICAN "PACEMAKER", MONARCH G. H., SOUTH BEND, AMERICAN AND LODGE AND SHIPLEY PRECISION AND TOOL ROOM LATHES; 5 WARNER-SWASEY AND GISHOLT 2A, 1A, NO. 3 PLAIN AND 3L TURRET LATHES; 5 KING, BULLARD AND COLBURN 32" TO 72" VERTICAL BORING MILLS; 2 GLEASON GEAR PLANERS; 5 MILWAUKEE AND CINCINNATI MILLING MACHINES; ROCKFORD SHAPER PLANER; DO ALL SAW; LANDIS GRINDER; KEY SEATERS; THREADERS; POWER SAWS; SHAPERS; SLOTTERS AND MANY OTHER MACHINE TOOLS.

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HYDROBLAST CLEANING SYSTEM; BEARDSLEY & PIPER MODEL S455 SAND SLINGER; HERMAN 7' X 10' JARRING MACHINE; HERMAN JOLT ROLLOVERS; JEFFERY FLASK FILLER; SIMPLICITY "D" SHAKE-OUT; SIMPSON SANDMIXERS AND MULLERS; CLEARFIELD SAND MIXER; COLEMAN "TRANSTRACK" CORE OVENS; ROD STRAIGHTENER; INCLINED SHAKE-OUT UNIT; WHITING CUPOLAS; CONNERSVILLE ROTARY BLOWERS; ROYERSFORD SCREENS; CONVEYORS; NILES FORGING HAMMER; FOUNDRY GRINDERS; TRACK SCALES; FOUNDRY SCALES; FOUNDRY SUPPLIES AND TOOLS.

14—OVERHEAD CRANES FROM 5 TON TO 30 TON CAPACITY

POWERHOUSE EQUIPMENT—AIR COMPRESSORS — MATERIAL HANDLING EQUIPMENT

NOTE: The Fulton Iron Works Company, now in its 98th year, is continuing in business. This sale is for the purpose of disposing of machinery and equipment only. All other operations of the Fulton Iron Works Company will continue as heretofore.

For Detailed Descriptive Circular WRITE — WIRE — PHONE

SAMUEL L. WINTERNITZ & CO.

AUCTIONEERS • LIQUIDATORS • APPRAISERS

FIRST NATIONAL BANK BLDG. **CHICAGO 3, ILL.**

1600 Horsepower in 60 square feet!

Those interested in gaining additional power output without costly new construction should mark this:

Often the fact that Opposed-Piston diesel engines pack so much power in so little floor space makes it possible to increase plant capacity without expanding or remodeling the room or building now being used. For instance, a 1600 hp. Opposed-Piston engine can be installed on the same foundation required by the average slow speed engine of one-third the horsepower!

This is important—especially so when coupled with the facts that Opposed-Piston diesels have a world-wide record for low-cost, long-lived service, and are now available as dual-fuel engines for use with natural or sewage gas. Fairbanks, Morse & Co., Chicago 5, Ill.

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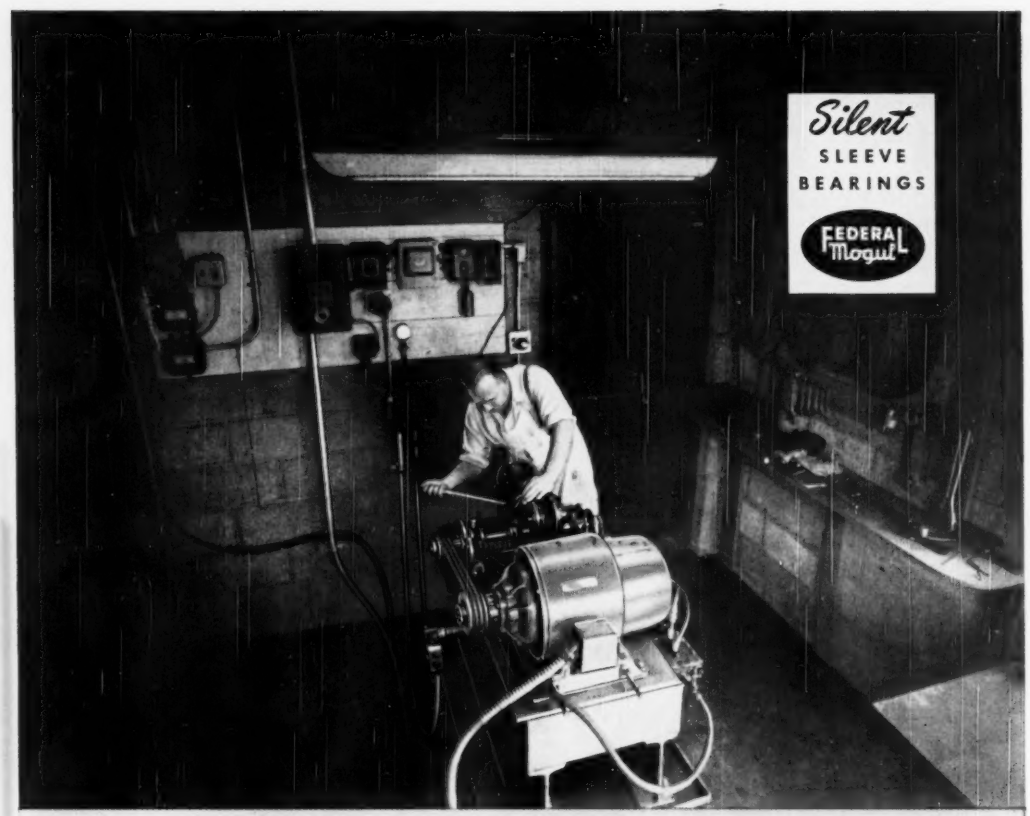
a name worth remembering

DIESEL LOCOMOTIVES AND ENGINES • ELECTRICAL MACHINERY • PUMPS • SCALES
HOME WATER SERVICE AND HEATING EQUIPMENT • RAIL CARS • FARM MACHINERY



Sleeve Bearing Torture Chamber

Here, bearings are given really brutal tests. In just a few hours, they get a tougher workout than they would get in years of normal service. This "third degree" treatment makes any bearing tell all about its performance capabilities.

Can it stand high heat? . . . heavy load? . . . high speed? . . . pounding? . . . The research engineer answers all of these questions, and more.

Because he knows that there is no *universal* bearing material, the research engineer must establish fields of usefulness for many bearing alloys. Working within the limits of each, he specifies which will be best for the particular set of operating conditions to be met.

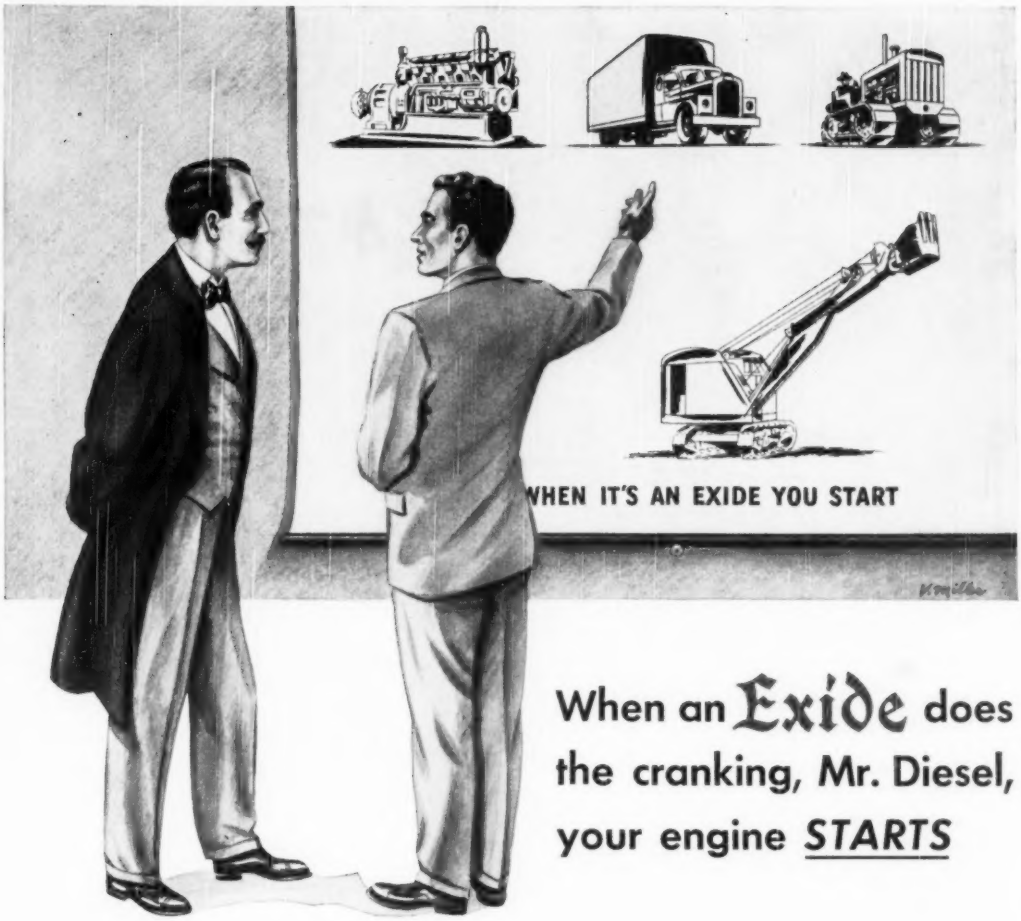
He has the answers to questions that may not be asked by the engine builders for several years. This is as it should be. The research engineer must think ahead, plan ahead, and have tomorrow's sleeve bearings ready today!

Our engineers have had millions of dollars' worth of experience—take advantage of it in *your* sleeve bearing requirements!

FEDERAL-MOGUL

Federal-Mogul Corporation
11041 Shoemaker, Detroit 13, Michigan

OVER FIFTY YEARS OF CONTINUOUS BEARING EXPERIENCE



When an Exide does the cranking, Mr. Diesel, your engine STARTS

You can count on sure starting, because an Exide Battery is built specifically for the job . . . built to deliver the mighty surge of cranking power a Diesel engine needs.

Whether you're a manufacturer or operator of Diesel engines and Diesel-powered equipment, that means you can depend on your Exide Diesel Cranking Batteries for:

- high maintained voltage—a *quick breakaway* and *high cranking speeds*.

You also get:

- long life—low depreciation, less frequent replacements.
- low costs—operating, maintenance, repair.
- rugged construction, for heavy-duty service in all climates.

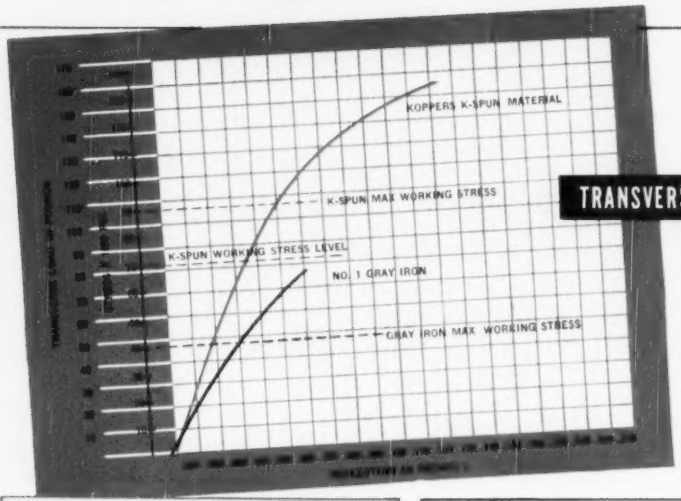
For maximum economy and dependability, use Exide Batteries for all your Diesel cranking—buses, trucks, trailer-tractors, off-the-highway equipment, ships, power plants, Diesel-electric locomotives.

TO HELP YOU GET TOP CRANKING performance, Exide's Engineering Staff, the largest in the industry, will be glad to help you solve any of your Diesel-cranking problems.

THE ELECTRIC STORAGE BATTERY COMPANY
Philadelphia 32
Exide Batteries of Canada, Limited, Toronto
"Exide" *Reg. Trade-mark U. S. Pat. Off.*

1888 . . . DEPENDABLE BATTERIES FOR 62 YEARS . . . 1950

Here's PROOF that Koppers K-Spun Piston Rings are TWICE AS STRONG!



HERE ARE THE AMAZING RESULTS OF ACTUAL LABORATORY TESTS COMPARING ORDINARY GRAY IRON WITH KOPPERS K-SPUN, *THE MIRACLE METAL!*

TRANSVERSE STRESS CHART

Koppers K-Spun material shows a maximum working stress of 90,000 psi, compared with a maximum working stress of *only 40,000 psi for ordinary gray iron piston ring material!* Note the difference in the slopes of the two curves, due to K-Spun's increased modulus. K-Spun's yield point, though approaching ultimate strength, is low enough to allow a small percentage of elongation, resulting in toughness and impact value *many times greater* than that of ordinary gray iron.

TABLE 1—TRANSVERSE MODULUS AND RUPTURE STRESS

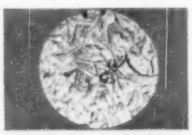
Koppers K-Spun Material			No. 1 Gray Iron		
TRANSVERSE MODULUS at			TRANSVERSE MODULUS at		
40,000 # psi	60,000 # psi	90,000 # psi	40,000 # psi	60,000 # psi	90,000 # psi
22.0×10^6	20.6×10^6	18.6×10^6	12.4×10^6	10.8×10^6	
RUPTURE STRESS psi			RUPTURE STRESS psi		
130,000			67,000		

TABLE 2—HARDNESS, IMPACT AND TENSILE STRENGTH

Koppers K-Spun Material			No. 1 Gray Iron		
Hardness Rb	Impact in lbs.	Tensile Stren., psi	Hardness Rb	Impact in lbs.	Tensile Stren., psi
100-103	9.5- 9.5	75,400	102-104	2.5-3.0	42,000
99-100	11.0-11.5	72,900	103-104	2.5-3.0	40,000
105-106	7.0- 5.0	76,000	101-103	3.0-3.0	41,000
99-102	7.0- 8.0	79,100	103-105	2.5-3.0	42,000
98-100	8.5-10.0	76,500	104-105	3.0-3.0	42,300
103-104	6.0- 7.0	77,500	102-103	3.5-3.5	38,000
101-102	7.0- 8.5	78,000	104-105	2.5-2.5	40,000

IF you've had experience with Koppers American Hammered Rings in Diesel, steam or gasoline engines, you already have *proof of performance* of their superiority . . . now read for yourself these scientific facts and figures, verified by exhaustive laboratory tests . . . *positive proof that K-Spun Rings are 100% stronger, 50% more elastic, four times more shock resistant than ordinary ring material!* They're *guaranteed* not to break in installation or in service! Get the facts on Koppers Piston Rings today . . . write for complete information to: KOPPERS CO., INC., *Piston Ring Dept.*, 1545 Hamburg Street, Baltimore 3, Maryland.

K-SPUN IS AN ENTIRELY NEW, STRONGER KIND OF CAST IRON



ORDINARY CAST IRON

KOPPERS K-SPUN

These microstructures, magnified 250 times, show the basic difference between ordinary cast iron and Koppers K-Spun. Top photo shows individually cast gray iron, containing spiral flake graphite with long stringers in a fine pearlitic matrix. This fine flake graphite imparts to the metal many planes of weakness, causing low resistance to combustion shock.

Bottom photo shows K-Spun, cast by an exclusive centrifugal process. Note large nodular type of graphite formation and absence of stringers. Large graphite nodules eliminate the many planes of weakness inherent in most cast iron . . . double impact resistance and elasticity . . . increases wear resistance by far . . . in amazing Koppers K-Spun Piston Rings!

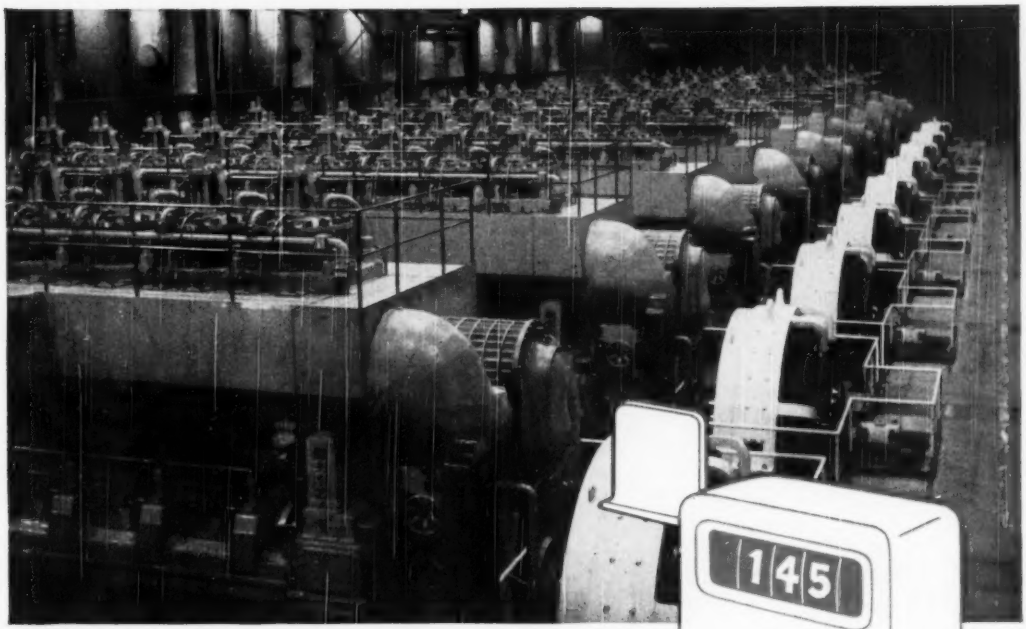
POROUS CHROME PISTON RINGS

. . . another Koppers Exclusive!

Koppers Porous Chrome Rings reduce cylinder wall wear 50% or more by actual test! Famous Van der Horst Plating Process provides a porous chrome surface that distributes oil for better lubrication during break-in, wears down to perfectly seated solid chrome that gives up to four times as much service between overhauls! For gasoline and Diesel engines (on specification).

KOPPERS

KOPPERS *American Hammered* PISTON RINGS



"ENGINE DOWN TIME... was ticking away like a taxi meter!"

"SOMETHING HAD TO BE DONE FAST. Production hold-ups were costing us plenty. We knew the trouble—improper lubrication—but after the most patient experiments with one lubricant after another we were still baffled.

"When down time really became critical, we called in a Cities Service Lubrication Engineer. This man knew Diesels from A to Z. He pointed out that the right grade and the right type of oil can easily make the difference between dependable performance and excessive down time.

"Without laying a wrench on any engine he diagnosed the problem quickly and accurately. His recommendations based upon his extensive Diesel experience and making use of his wide range of top quality Cities Service new Heavy Duty Diesel oils proved completely satisfactory. After six months of performance with a bare minimum of engine down time we are convinced the Cities Service Lubrication Engineer knew his business . . . and knew his products."

For the services of a skilled Cities Service Lubrication Engineer contact the office nearest you or write us for information. If you have a lubrication problem involving Diesel engines of any make or model, we'll be happy to discuss it with you.

A complete line of top quality lubricants

- **New Heavy Duty Diesel Oils**
- **New Top Performance Diesel Fuels**
- **Service-Proved Diesel Oils**
- **Exclusive Exhaust Analyzer Service**

FREE! THIS HELPFUL NEW BOOKLET

CITIES SERVICE OIL COMPANY
Sixty Wall Tower, Room 585
New York 5, New York

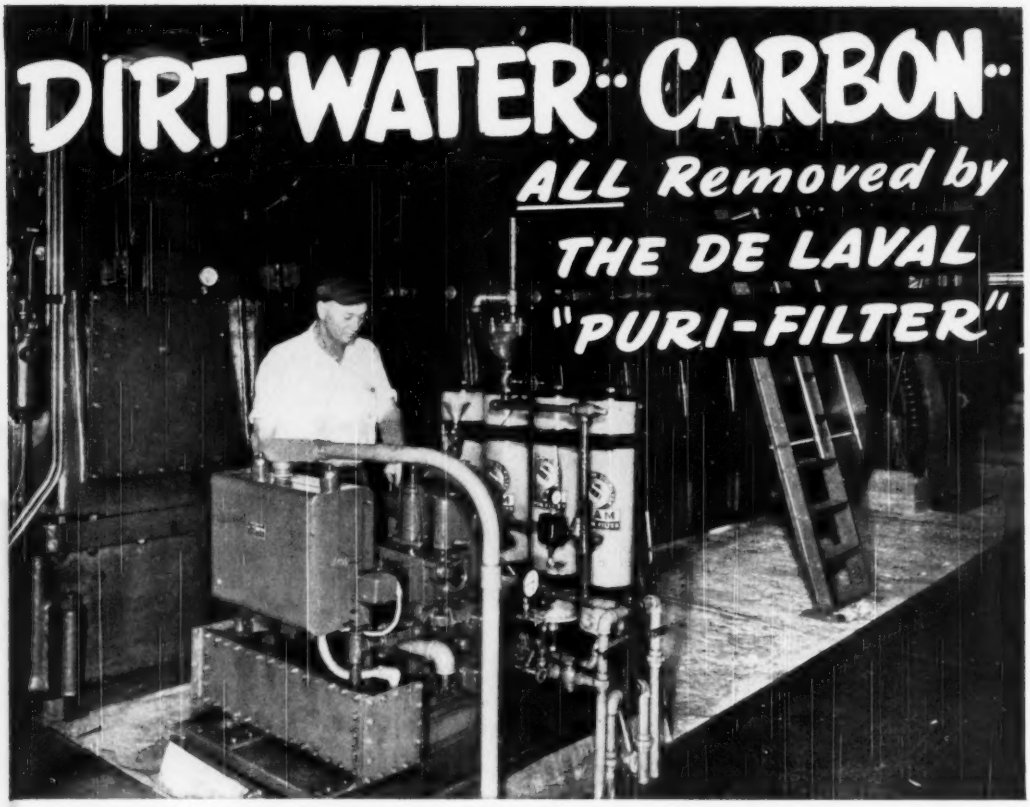
Please send me without obligation your new booklet entitled "Diesel Engine Lubrication."

*Name*_____

*Company*_____

*Address*_____

*City*_____ *State*_____



THE De Laval "Puri-Filter" removes all major contaminants of Diesel lubricating oil: dirt, water and carbon. The first two are thrown out of the oil by centrifugal force applied in the bowl of the De Laval Oil Purifier—the water being discharged continuously. The colloidal carbon is then filtered out of the purified oil by the Fram filters.

Analyses of oil samples taken from many "Puri-Filters" now in service show that practically all of the material that causes gums, sludges, "cokes," etc., is eliminated by the combined effects of centrifuging and filtration. Elimination of this material, normally in suspension even in detergent type oils, means less ring sticking . . . better engine performance . . . the utmost in protection.

• *Write for additional details.*

THE DE LAVAL SEPARATOR COMPANY
165 Broadway, New York 6 427 Randolph St., Chicago 6
DE LAVAL PACIFIC CO., 61 Beale St., San Francisco 5
THE DE LAVAL COMPANY, Limited, Peterborough, Ont.

DE LAVAL *Oil Purifiers*

FOR DIESEL LUBRICATING OIL

Statistical and Metallurgical Control Govern Quality of Eaton Valve Lifters

Eaton has developed outstanding facilities for the manufacture of valve lifters and associated parts.

Statistical Control of key operations provides a visual record of adherence to established limits.

The development of specialized types of chilled irons, and highly precise methods of metallurgical control, are important factors in Eaton quality.

EATON MANUFACTURING COMPANY

CLEVELAND, OHIO

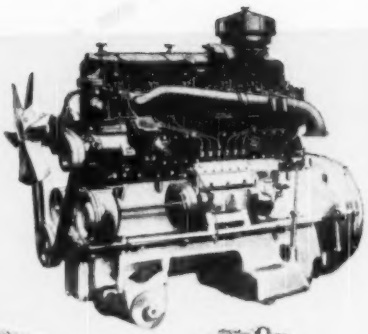
VALVE DIVISION: 9771 FRENCH ROAD • DETROIT 13, MICHIGAN

EATON PRODUCTS: Sodium Cooled, Poppet, and Free Valves • Tappets • Hydraulic Valve Lifters • Valve Seat Inserts • Jet Engine Parts • Rotor Pumps • Motor Truck Axles • Permanent Mold Gray Iron Castings • Heater-Defroster Units • Snap Rings Springtites • Spring Washers • Cold Drawn Steel • Stampings • Leaf and Coil Springs • Dynamatic Drives, Brakes, Dynamometers

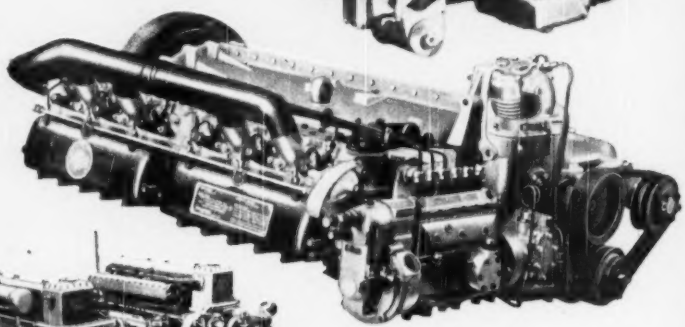
A famous source of
BRITISH POWER
ON LAND AND SEA

The symbol of A.E.C. is familiar from Norway to New Zealand . . . South America to Singapore! It is the sign of reliable, economical power that is activating land and marine transport and turning wheels of industry all over the globe. It is the herald that proclaims the identity of most of the buses that carry 7½ million Londoners daily. It is a symbol of world-wide service that is available from A.E.C. agents and depots in most countries in all continents. Above all, it is the trade-mark and guarantee of fine Diesels . . . there are no finer operating anywhere today.

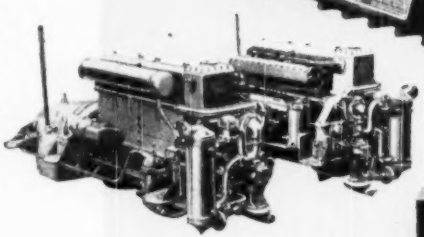
A.E.C. 9.6 litre 6-cylinder vertical Diesel for Road Transport work



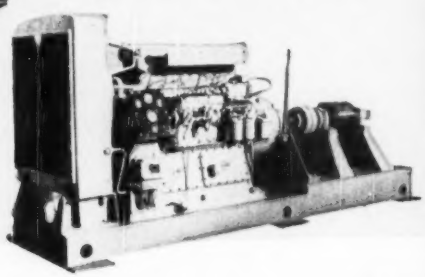
A.E.C. 11.3 litre 6-cylinder horizontal Diesel for Transit type bus.



A handed pair of A.E.C. 6-cylinder marine Diesels with an individual power rating of 100 B.H.P.



The A.E.C. 9.6 litre stationary Diesel develops 100 B.H.P. at 1,500 R.P.M. continuous rating.



AEC

SOUTHALL

ROAD TRANSPORT • MARINE & INDUSTRIAL DIESELS

CANADA
THE ASSOCIATED EQUIPMENT CO., OF CANADA LTD.
Keefer Buildings.
1440 St. Catherine Street West.
Montreal.

A.E.C. LIMITED, SOUTHALL, MIDDLESEX, ENGLAND
Subsidiary of Associated Commercial Vehicles Ltd. London

BUILDERS OF LONDON'S BUSES

Are YOU using the FILTER that advanced Filtration as much as the DIESEL advanced the internal combustion engine?

WHICH

is the only micronic filter that works by a positive mechanical principle?

Cuno MICRO-KLEAN consists of a cartridge of fibres distributed under scientific control. It positively removes all injurious solids from Diesel fuel. Resinous-impregnated cartridge, unaffected by moisture, etc., won't soften, swell, harden, rupture or release contaminants to clog injectors or damage pump. (MICRO-KLEAN can be installed on suction side of pump.)

Diesel users will like . . .

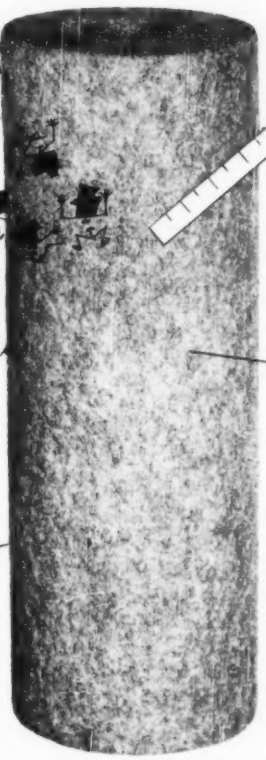
Longer life—Exclusive "graded density in depth" permits smaller particles to penetrate to varying depths—doubles dirt-holding capacity.

No Channeling—Resinous impregnation and polymerization prevents channeling, rupturing, etc.

Low pressure drop

No removal of additives from lube

No danger of cartridge failure—Impervious to crankcase acids, moisture, other damaging agents.



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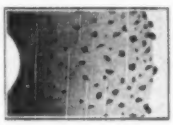

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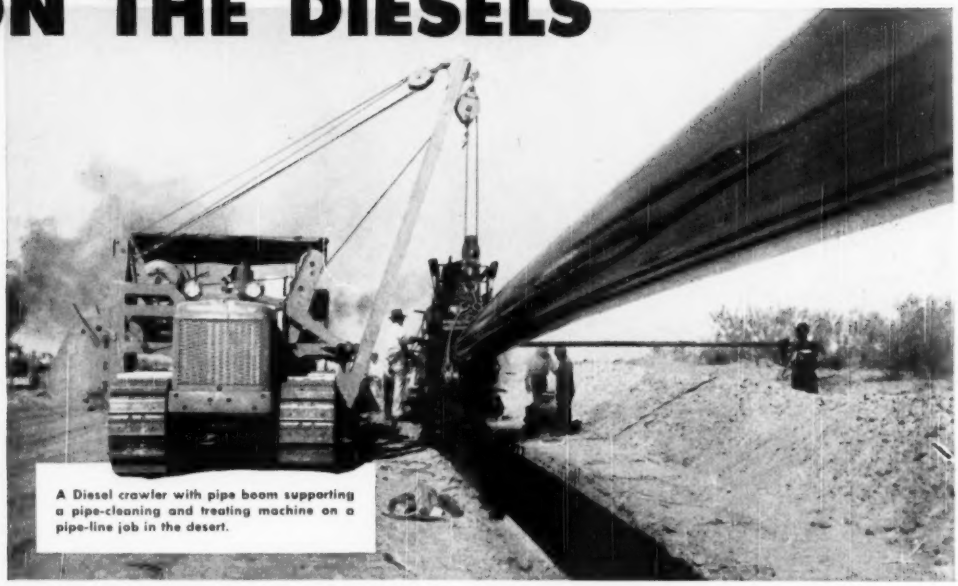

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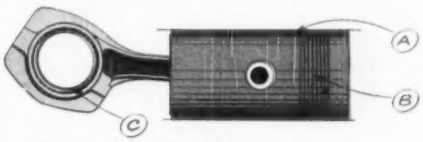

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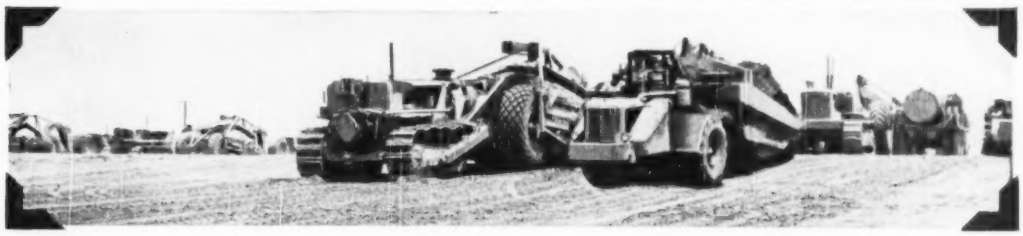

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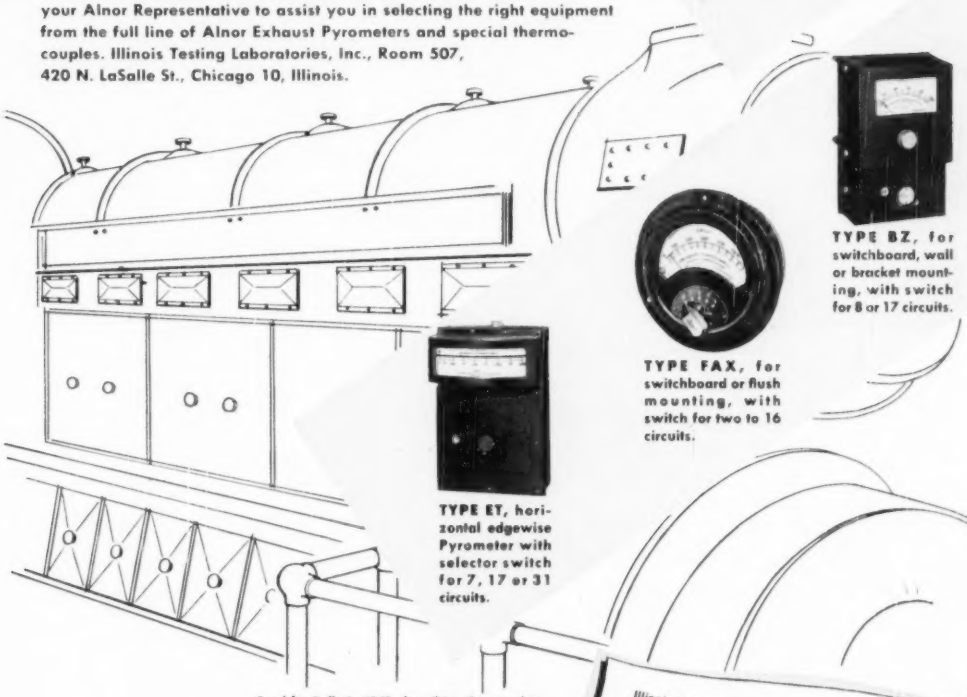

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A night view of the La Junta, Colorado plant.

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Editorial:

Technicians for Industry

Recently, we were invited to serve on an advisory committee to the Division of Industrial and Related Fields of the Long Island Agricultural and Technical Institute. Reason? Because this Institute, functioning as a part of the University of the State of New York, has incorporated in its curriculum a course of study in internal combustion engines, both gasoline and diesel. The first visit was exploratory but was productive of a number of interesting ideas worthy of comment.

In the first place, the expressed idea behind the formation of advisory committees drawn from industry is to determine the current practices and requirements of various industrial fields so that the courses of training will be of greater practical value when the student is graduated. The overall plan is greatly similar in principle to the educational program of DEMA. Extension of this idea should prove, if such evidence is needed, that DEMA is on the right track.

In describing the project and giving the background of the Institute, Director Knapp made an interesting point. These courses, for high school graduates generally taking two years for completion, are aimed at creating a new skill category termed "technicians".

The technician is described as the intermediate link between the skilled craftsman and the engineer. It is not enough that he be capable of producing an acceptable product or service; he must know the "why". He must be capable of understanding, interpreting and implementing the ideas of the engineer and also be able to assume the responsibility of supervision and leadership.

A comprehensive survey of industry undertaken by the State of New York showed that technology in industry had advanced to the point where an average of eight technicians were required for each engineer. The next step, the skilled worker, formed a much broader base for the pyramid. The survey also included an evaluation of the job opportunities in various industries.

This very practical approach to the determination of a curriculum serves two purposes: it helps in directing students into profitable paths, and feeds industry with the skills most needed. Having determined the need, the next step is to provide the type of training necessary. Here, the advisory committees play their part.

Another part of the training that is of interest is the recognition of the human factors of earning a living. A portion of the course is devoted to the business of getting along with people. This includes the principles of supervision; facility of expression, both written and oral; and an indoctrination as to the responsibilities of such individuals at company level, community-wise and higher.

The latter may be felt to be extraneous to a technical course or even, perhaps, idealistic. Think, a minute. How many people do you know that fit the comment, "He knows his stuff, but he can't get along with anybody". The labor movement has served to emphasize the importance and necessity of "human engineering" and the foresight of an educational institution that is aiming at supplying a specific and higher level type of skilled worker is notable.

Bearing in mind that the survey indicating basic industrial needs dictated the type of instruction, it is interesting to note that the diesel course is combined with that for gasoline engines. It was determined that the owner of, say, a mixed fleet of diesel and gasoline powered equipment or one with just a few pieces of equipment could not afford the luxury of a strictly diesel technician. A knowledge of both types of engines, as well as the rest of the piece of equipment, greatly widened the employment opportunities.

Without going into details of the course, it can be said that it is comprehensive, with a considerable portion devoted to supplementary background subjects such as machining, welding, etc. At the higher level, mathematics, physics, etc. are taught.

This educational trend appears to us as being commendable and an answer to a long felt need. Various persons representing industry commented that their organizations had recognized this "technical" level and had even provided for it in their job evaluation. In any case, surveying the needs of industry and then asking their help in determining their specific educational requirements should result in better men — an asset to any industry.

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+ HIGHLIGHTS +

● Class I railroads on March 1 had 1111 new locomotives on order, which included 1095 diesels.

● In 1949, the British produced industrial diesel power of 962,640 hp. according to The Oil Engine and Gas Turbine, a British publication.

● The first natural gas well in the State of Maryland to produce in commercial quantities was completed recently near Oakland.

● You are more than four times as likely to be killed in an automobile accident between seven and eight in the evening as you are between seven and eight in the morning.

● Because of the increased use of aluminum foil, the Aluminum Association organized a foil division late last year, bringing to four the number of active divisions in the Association.

● Denton, Texas, continues to expand its diesel plant with two new Nordbergs, recently installed, which, with the two Enterprise engines already in operation make a total of four engines in the plant.

● The Creole Petroleum Corp., by a 50-50 partnership with the people of Venezuela, has demonstrated that U. S. business can help make use of the rich natural assets of other nations without exploiting other peoples.

● The two largest electric locomotives ever exported by General Electric have been shipped to South America. The 230-ton giants, each with a 4000-hp. rating, will haul freight and passengers through Chilean mountains.

● The owners of U. S. industry, or those who receive any profits, get less than 5 per cent of all the money earned by industry.

● A new type governor, designed specifically for small hydraulic turbines has been introduced by Woodward Governor Company.

● Latest flameproof underground locomotives for British mines have carbon monoxide content of diesel exhaust reduced below half the U. K. government minimum.

● A 60-kw. diesel generator set weighing only 3300 lbs., is the latest piece of lightweight equipment developed for the Navy Bureau of Yards and Docks.

● Great Britain's state-owned transport system is running into the red to the tune of $1,400,000 weekly, according to the British Transport Commission.

● The mechanization of farming has meant a $5000 to $20,000 investment in machinery for the average farm, a large percentage of which is diesel-powered.

● Boeing Airplane Company has built and tested two small gas turbines for industrial use, one of which has a continuous rating of 160 hp. Fuel consumption is still a problem in these units.

● To supply more electricity to light her homes and run her factories, Great Britain is engaged in a scheme to tap the gales which sweep in from the Atlantic using windmills. If a modern Don Quixote shows up, what will the English planners do?

● The Santa Fe's newest train, the Kansas City Chief, will feature a club car decorated in the style of the 1890's.

● A railway generator set rated at 10,000 kva. is on its way to Mexico City. Apparently the Tacabuya plant is not enough.

● In the last quarter century, the American oil industry has increased domestic crude oil output by 157 per cent.

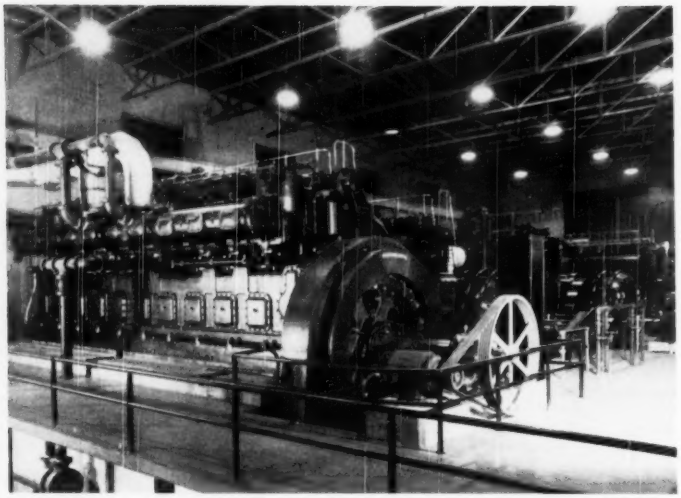
● Full-time paid policewomen are now employed in at least 161 cities of over 25,000 population according to the International City Managers' Association.

● Diesel-powered portable saw mills driven through a Twin Disc Power Takeoff average 1000 feet of lumber per hour, sawing mixed hard and soft timber in central Wisconsin.

● At their recent convention, the American Road Builders' Association passed a resolution calling for a $4 billion a year highway construction program spearheaded by Federal aid of at least $1 billion.

● Capable of handling torque loads up to 300 hp. at 9000 rpm., a new flexible drive coupling, commercially developed, is undergoing service tests at the Air Materiel Command, Dayton, Ohio.

● A leading automotive engineer has forecast that Americans will not be driving atomic automobiles in the near future since about 25 tons of steel and concrete would be needed just to protect the passengers from radiation effects.



Five F-M diesels, totaling 6725 hp., in the La Junta plant. Converted engine is at far end with new unit in foreground.

La Junta Converts to Dual-Fuel

Ten year operating record shows benefit to community totaling $1,000,000. One year of operation with converted F-M engine pares costs. New dual-fuel engine and further conversion gives promise of still cheaper operation.

by William H. Gottlieb

CELEBRATING its tenth anniversary, the La Junta, Colorado, municipal power plant, one of the major diesel plants in the Southwest, is making impressive news again. First, it is revealed officially that the 1750-hp., 10-cyl., 16 by 20-in. Fairbanks-Morse diesel has been converted to dual-fuel operation, the first dual-fuel engine of its size and type, and has completed a full year of successful service. Second, a new 2000-hp. Model 33FD16 Fairbanks-Morse dual-fuel engine has been installed, bringing plant capacity to 6725 hp. Third, the other older diesels are being converted to dual-fuel with a fuel saving estimated at more than $50,000.00 a year. Fourth, in ten years, the plant has generated more then 90,000,000 kw. hr. with benefits to the community totaling more than $1,000,000.00.

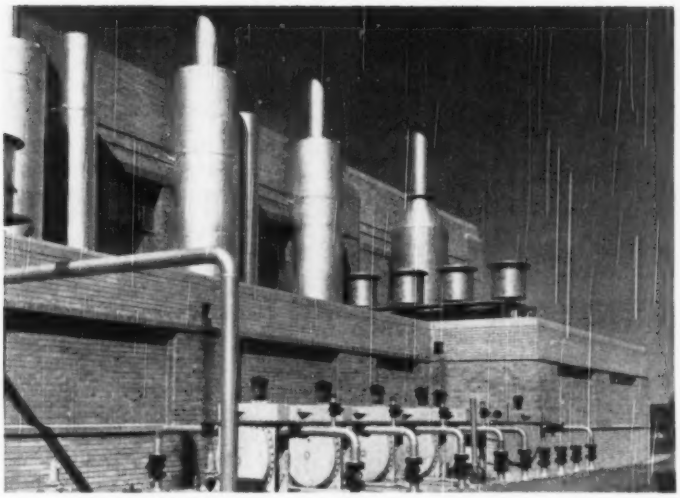
These accomplishments have significance far beyond the boundaries of La Junta. They mean that every F-M, 16 by 20-in. diesel, the first of which was manufactured in 1929, can be converted to utilize gas fuels with important savings wherever cheap gas is available. This convertibility was deemed important by Fairbanks-Morse engineers in designing their new dual-fuel engines and the converted units are the same as the new units in all essentials.

For example, this description of fuel handling at La Junta applies to both the 1750-hp. and the 2000-hp. engines though the first was converted and the second built originally as a dual-fuel unit. The 900-Btu. natural gas reaches the plant at 50 psi. and passes through an individual meter and pressure regulator for each engine where it is reduced to 15 psi.

Before reaching the engine, the gas must pass, first, through a safety cut-off valve actuated by engine lubricating oil pressure. This valve admits gas only if the engine is turning over fast enough to bring lube pressure to operating level; if fuel oil pressure is adequate, and if engine speed is not excessive. The gas next passes through an admission valve controlled by governor linkage, through a header along the cylinder heads, and finally through cam-actuated valves into each cylinder. The valve lift and timing at the cylinders are constant and only the pressure in the gas header (controlled by the governor) regulates the quantity of gas injected.

The charge of pilot oil which initiates combustion does not vary in quantity and is injected by a separate small-volume fuel pump for each cylinder, permitting a precisely regulated supply. The engine also is equipped with standard diesel fuel pumps which function when the engine is operating wholly on oil and cut in automatically to compensate for any gas deficiencies during dual-fuel operation. Both pumps use the same injection nozzle.

Finally, to insure a favorable gas-air ratio, a governor-regulated valve controls the quantity of scavenging air admitted to the cylinders. The gas and air supplies are separate entities, independently controlled, so that there



Equipment for three essential functions: the air filters, exhaust silencers and the gas regulators and meters.

is always sufficient air for full combustion even with gases of low Btu. content such as sewage gas. Also, the physical isolation of the gas system at the top of the engine is an added safety factor.

Like the fortunate prospectors who found rich ore in Colorado, La Junta has made pioneering pay profits. The city cooperated fully with the engine builder's design engineer in the development and adjustment resulted in a 50 per cent reduction in fuel costs, a solid saving of more than $15,000.00 for the first year on that one unit's operation.

In 1949, the 1750-hp. engine was the mainstay of the plant, operating virtually all the time and producing close to 6,000,000 kw. hr. Costs of gas and fuel oil for this unit were cut steadily throughout the year down to 4 mills per kw. hr. Further refinements are expected to bring the conversion to the full efficiency of a new dual-fuel unit.

The new 2000-hp. engine was first put to work on Dec. 8, 1949. By March 13, 1950, the unit had run 1120 hr. and generated 1,096,300 kw. hr.

A combination of economical power production and sound business management has paid high dividends to the citizens of La Junta. The very day the diesels started turning in 1940, the city announced a 10 per cent cut in existing power company rates. Exactly one year later, an additional 5 per cent reduction was put into effect. On June 15, 1949, still another 10 per cent cut was ordered, giving La Junta one of the lowest rate schedules in Colorado. At power company rates, the consumers' purchases for the ten years would have cost $2,205,634.47; at municipal rates they actually cost $1,-88,388,348.56, a saving of $326,678.67. (*Actually this figure covers 9½ years, for the added savings of the last six months have not yet been calculated.*)

In addition, the plant has provided free services such as street lighting, Christmas lighting, athletic field floodlighting and park lighting which would have cost the city at least $20,-000.00 a year or a total of $200,000.00 for the ten years. Also, the municipal utility pays the city substantially more in taxes than did the private utility—an average of $9,893.58 a year as compared with $2,500.00, a net gain to

Table I
Plant Operating Expenses

Year Ending June 30	Total Operating Revenue	Supervision and Labor	Fuel	Lube	Water	Supplies	Maint.	Total Plant Operating Cost	Total Expenditures**	Net Profits
1940*	33,532.29	1,925.60	6,006.89	991.62	30.00	386.77	372.75	9,713.63	26,452.01	7,080.28
1941	148,406.83	6,890.92	20,309.37	1,030.50	114.00	1,127.51	1,675.89	31,148.19	83,330.51	60,076.32
1942	148,123.61	9,151.49	20,747.44	1,051.11	120.00	1,461.41	1,932.11	34,463.56	91,711.30	56,412.31
1943	178,012.64	9,879.94	31,022.38	1,768.47	130.00	1,634.80	2,038.31	46,473.90	110,857.32	67,155.32
1944	224,184.97	12,478.20	52,045.67	2,643.83	120.00	2,326.99	1,991.53	71,606.22	137,130.17	87,054.80
1945	238,821.06	13,030.18	54,407.72	2,650.00	120.00	7,626.59	2,116.12	79,952.61	142,489.41	95,331.65
1946	231,822.22	15,774.28	45,300.36	2,683.39	140.00	5,722.26	2,309 00	71,929.29	140,428.73	91,393.49
1947	249,493.10	19,157.77	62,237.80	4,238.13	301.00	4,748.19	6,424.71	97,107.60	172,787.11	76,705.99
1948	268,491.08	20,093.88	95,928.83	4,831.26	120.00	4,495.92	8,201.90	133,671.79	203,077.16	47,512.78
1949	282,947.65	22,084.55	94,260.96	4,599.14	120.00	5,007.74	6,858.26	132,930.65	220,978.30	61,969.35
Totals	2,003,835.45	130,466.81	482,269.42	26,487.45	1,315.00	34,538.18	33,920.58	708,597.44	1,339 262.02	664,573.43

*3 months
**Excludes plant operation, distribution, administration, taxes, interest, depreciation.

the city of $73,935.80 for ten years.

Yet, in spite of successive rate reductions, in spite of free services, in spite of higher tax payments, and in spite of rising costs in an inflationary period, the diesels earned for La Junta an impressive profit. By the close of the fiscal year ending June 30, 1949, operating revenues for the life of the plant totaled $2,003,835.45 while total expenditures, including plant operating, distribution, administration, taxes, interest and depreciation, came to $1,339,262.02, leaving a clear net profit of $664,573.43. Again the figure for the full ten years is not yet available and would show an even larger profit. Table I gives detailed annual figures for the period cited and shows how income kept climbing despite the rate cuts. The actual reduction in fuel costs from 1948 to 1949 while kw. hr. output rose reflect the city's aggressive action to combat high oil prices by turning to natural gas.

Here's the simple total of the financial benefits described above:

Consumer rate savings (9½ yr.)	$ 326,678.67
Free services (10 yr.)	200,000.00
Higher tax payments (10 yr.)	73,935.80
Net profits (9¾ yr.)	664,573.43
Total	$1,265,187.90

Fuel is an important cost factor but it is by no means the sole determinant of a power plant's success. The late W. H. Goodhue, utilities superintendent who built the plant, and Henry Klein, who was Mayor when the plant was started, believed in heavy duty prime movers, good protective accessory equipment, alert and methodical operating, and careful cost accounting. D. J. Goodhue, the present utilities superintendent, chief engineer B. A. Kibler, and members of the Power Board hold the same views and are implementing them. Thus, the 2000-hp. engine is of the same type as its four predecessors and develops its rated horsepower at a moderate 300 rpm.

Lubricating oil is cleaned continuously by circulation through a filter with cotton-waste elements. The full pressure lubrication system which supplies the bearings and cools the pistons includes an engine-driven pump and a shell-and-tube cooler. A motor-driven auxiliary pump is used to circulate lube before starting and after shutting down the engine. Fuel oil is passed through a cotton-waste filter before the day tanks and also through a special filter on the engine to protect the pilot oil pumps.

Scavenging air for the big engine is drawn through a battery of four oil-bath air filters and supplied to the engine by a blower driven by a 125-hp. motor. This motor is powered directly from the engine-driven alternator. A 48-volt wet cell battery forces the field of the alternator, insuring a quick supply of power to drive the blower when the engine is started. Engine exhaust gases vent through vertical silencers at the side of the plant.

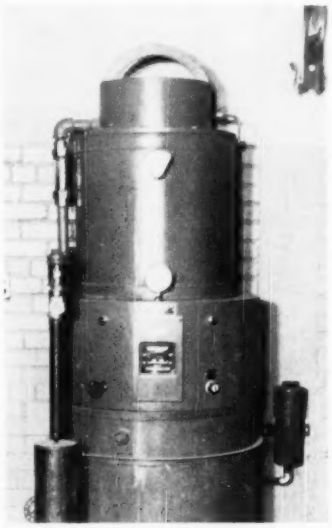
La Junta's 58-grain water is softened in two hot wells and circulated by five motor-driven centrifugal pumps through the engine jackets and the coils of a three-section forced-draft cooling tower. Four additional pumps handle the raw water for the tower.

Separate records are kept of operation, production, fuel and lube consumption, maintenance work and expenditures for each engine in the plant. This serves as a guide to intelligent and economical operation. That kind of operation is paying off handsomely in benefits to the plant's collective owners. The records indicate that conversion to dual-fuel will raise profits and attendent benefits to new heights.

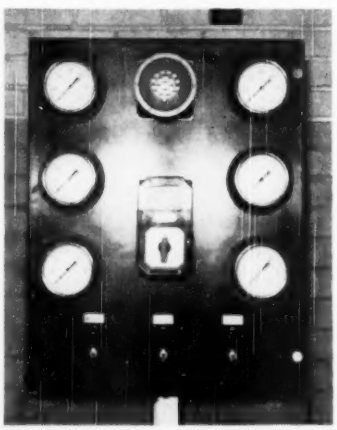
The utilities system is managed by Mr. Goodhue under the supervision of a Power Board consisting of Mayor M. B. Chase, three members elected for six-year terms, and a representative of the City Council.

Principal Equipment Serving New Engine

Alternator	*Fairbanks, Morse & Co.*
Switchboard	*Westinghouse Electric & Mfg. Co.*
Governor	*Woodward Governor Co.*
Scavenging air blower	*Roots-Connersville Blower Corp. driven by F-M motor.*
Lube filter	*Midwest Filter & Mfg. Co.*
Lube cooler	*Ross Heater & Mfg. Co.*
Auxiliary lube pump	*Geo. D. Roper Corp.*
Air filters	*Air-Maze Corp.*
Exhaust silencer	*Maxim Silencer Co.*
Cooling tower	*The Marley Co.*
Cooling water pumps	*Fairbanks, Morse & Co.*
Fuel filter	*Midwest Filter & Mfg. Co.*
Gas meter and regulator	*Emco.*
Exhaust pyrometer	*Brown Instrument Co.*



Continuous lube oil filtration is provided by the unit above. Below is the gauge and alarm panel for the new engine.



Diesel Motor Trains—Part II

by Stanley Berge, Associate Professor
and
Donald L. Loftus, Research Assistant
Northwestern University School of Commerce

Economy of Operation

Measurement of Operating Costs

IN any discussion of operating costs, the terms "out-of-pocket," "direct," and "full" costs usually arise. Although these terms are widely used in cost studies, they are not always clearly defined.

Out-of-pocket costs, also frequently termed "variable" costs, are those expenses which are incurred if a train or service is operated, and which disappear when that train or service is eliminated. These costs represent amounts actually expended to maintain operations. As such, they generally include practically all of the directly assignable operating costs. The most striking exception is depreciation expense, which, although directly assignable to freight service or passenger service in most cases, is not usually classed as an out-of-pocket expense. The full expenditure for the property has previously been made; consequently, no additional outlay of funds is necessary for continuing operations. Over a long period of years this would not be strictly true, since some expense of equipment replacement would be necessary, but in the short-run there would be no out-of-pocket outlay in order to maintain service.

The methods of determining which expenses are out-of-pocket vary between different cost studies, but stated generally, about 80-90 per cent of the directly assignable costs may be classed as an out-of-pocket. For instance, a 1946 study of one western railroad indicated that approximately 84 per cent of the direct passenger service operating expenses were out-of-pocket costs. Out-of-pocket costs are of value primarily in determining which costs could and which costs could not be eliminated by removal of a particular train under study, or of passenger service in general. Out-of-pocket costs are also at times designated as "direct" costs, "assignable" costs, or "separable" costs, but these terms include such items as depreciation expense, which is generally not considered as an out-of pocket cost.

Direct costs are those which, by their nature, are directly attributable to a particular class of service (either passenger or freight) and related solely to that service. This classification does not include any portion of the so-called common expenses, which are divided between freight service and passenger service on bases prescribed by the Interstate Commerce Commission. For example, wages of trainmen or passenger trains are a direct passenger service expense, while maintenance of roadway used by both freight and passenger service is a common expense, incapable of being directly assigned to either type of service. Hence the former is a direct expense; the latter is not.

The term full costs, or "fully allocated" costs, is used to designate the total expenses directly assigned and apportioned to each class of service. As such, it includes all direct expenses, plus that portion of the common expenses apportioned to each service. These common or indirect expenses cannot be identified directly as a part of the service performed, but are clearly necessary if such service is to be offered. Direct expenses may be assigned directly to the cost of a particular service, but common expenses are incapable of direct charge, and must be apportioned on some equitable basis. Although this full cost is chargeable as passenger service expense, it does not follow that such cost could be entirely eliminated if all passenger service were removed.

The initial step in finding the cost of a particular train is to separate all expenses between freight and passenger service. With the direct expenses, this presents little difficulty. Fuel for passenger locomotives is clearly a passenger service expense, as is operation and maintenance of a terminal used only for passenger traffic. Many expenses are directly chargeable to either passenger or freight service; many others, however, are not capable of being directly allocated.

Direct Costs for Individual Trains

For the past several years, direct passenger service expenses (those related solely to passenger service and capable of being assigned directly to that service) have averaged between 70 per cent and 72 per cent of total passenger service operating expenses for Class I steam railroads. These direct expenses are of two general types: (1) those which may be separated as between individual trains, such as wages of enginemen and trainmen on a particular run, and (2) those which benefit passenger service as a whole, but cannot be determined to benefit any particular train, as expense of maintaining passenger terminals.

That the Interstate Commerce Commission recognized the importance of selected direct operating expenses was indicated as early as 1915, when that body used seven direct operating expenses as a basis for dividing certain

other expenses between freight and passenger services. The seven Transportation-Rail Line expenses which were used in the Western Passenger Fares Case, decided December 7, 1915, were: road enginemen, fuel, water, lubricants, and other supplies for road locomotives, road trainmen and train supplies and expenses.

Motor Trains Reduce Costs

To present specific evidence of the economy of rail motor cars and motor trains as compared with locomotive-propelled trains providing equivalent service, representative cost studies and analyses by various railroads are cited. In every case there is a marked savings of motor train operating cost over the cost of operating trains propelled by locomotives. In most of these cases, as in a great majority of the cost studies conducted by railroads in this country and in other countries, only certain direct maintenance and operating costs were used.

It should be noted that while the various studies are not entirely comparable, one railroad with another, they do illustrate the relative economy of motor trains on each railroad, and generally indicate that small motor trains can be operated for approximately one-half the cost of a comparable steam train, and from two-thirds to three-fourths of the cost of an equivalent train propelled by a standard passenger diesel locomotive.

Economies of Early Motor Cars

In his book entitled Self-Contained Railway Motor Cars and Locomotives, published in 1921, Raymond S. Zeitler presented cost studies of some early gasoline-powered motor cars. The information covers a number of cars in operation just prior to World War I, and also includes comparative costs of steam and electric trains. When compared with steam, the operating costs of a gas-electric motor car in 1914 were found to be about one half.

In one study the mileage of both the motor car and the steam train was 3,882. The motor car was a Eubank gas-electric car powered by a 350-hp. engine, and of the same general type as those built by General Electric between 1906 and 1914.

The chief advantage of the internal combustion engine in transportation is its high efficiency. In comparison, steam power is relatively inefficient. This fact holds true whether the power is applied directly by the steam locomotive, or indirectly by distribution from a centralized electric power plant.

Another advantage of the internal combustion engine is the fact that with it, more power can be concentrated in a given space than with any other form of prime mover, thus making it particularly suitable for use in self-propelled rail motor cars and motor trains.

The operating economies of gasoline-powered motor cars in 1927 were revealed in a study made by the Boston and Maine. At that time the B&M found that it cost $1.59 to operate a steam passenger train one mile, excluding roadway or rail maintenance, while the cost of running a gasoline rail motor car on the same basis was only $0.72.

Much of the economy of the motor car may be attributed to its light weight and more efficient power plant. However, economies were also obtained through smaller crews, fewer servicing requirements, and reduced maintenance due to greater availability.

In 1931, the Burlington released some operating figures for its fleet of 57 gas-electric motor cars, which was at that time the largest number operated by any one railroad. These motor cars, most of which were of Electro-Motive design, covered a total of 3,341,004 miles in 1930, maintaining an availability of 94 per cent, and an operating cost equivalent to about 63 per cent of that of steam trains. Almost 60 per cent of the motor train mileage was made with either one or two trailer cars.

Costs Outside U.S.A.

Reports from other nations show that the savings of motor trains over locomotive-propelled steam trains before World War II were as great and often greater than in the United States. From the many cost studies made by foreign railways, a number are here mentioned to indicate the relative economies of motor trains in those countries.

In France, where immediately preceding the war, local railcars covered about 8.5 million train-miles over lines having a route mileage of somewhat under 4000, the cost of operating these cars was between 1 and 2 francs per kilometer, all charges included, as compared with a cost of 4 to 5 francs per kilometer for the steam trains they replaced. For the high-speed railcar service operated on certain main lines in France, the Assistant to the Chief Mechanical Engineer of the French State Railways stated that the operating cost of the best French railcars was about 4 francs per kilometer, or about half the cost of the steam trains replaced.

Spanish cost studies made just prior to the Spanish civil war in 1935-36 showed that diesel-mechanical railcars installed on the 125-mile Madrid-Cuenca line operated for only 21.5 per cent of the cost of the steam service replaced. The steam train showed operating costs of 3.524 pesetas per kilometer for the railcars. Similar studies during and after the war indicated that railcars on other Spanish routes operated at about 26 per cent of the cost of equivalent steam trains.

In Italy, immediately prior to the outbreak of World War II, the average operating cost of railcars in other than high-speed interurban service was 2.35 lire per railcar-kilometer, including maintenance, repair and depreciation. A two-coach steam train showed a corresponding operating cost of 4.92 lire per kilometer. The savings in this case were 52.2 per cent of the steam train costs, by use of railcars.

Diesel Motor Train Economies

The first lightweight motor trains introduced in America in the 1930's represented a two-fold attempt to increase the profitability of railway passenger service. In addition to increasing passenger revenue, they substantially cut operating costs. Evidence of this is shown by a number of cost studies made for the various motor trains then in operation.

Early in 1936 an analysis was made of the direct train operating costs of the Burlington "Zephyr" motor trains, which at that time had covered almost 650,000 miles. In comparison with the

steam trains they replaced, the direct costs of 31.41¢ per train-mile for the Zephyrs compared favorably with the steam train cost of 69.55¢ per train-mile. These costs were calculated using direct train operating expense accounts except that depreciation is not here included. The study showed Zephyr motor train operating costs to be only 45.2 per cent of that for the steam trains.

According to F. G. Gurley, who was then vice-president of the Burlington, the low maintenance costs of the "Zephyrs" were attributable to their high availability and continuity of service. This in turn was attributed in part to the fact that the "Zephyrs" were articulated, thus reducing the number of parts which required servicing and maintenance; the couplers, diaphragm buffers, draft gear, braking equipment, trucks and wheels being fewer.

The fuel savings afforded by the use of diesel power were further increased by the reduced weight of the "Zephyrs" which was due partly to articulation, partly to the smaller power plants, and partly to the use of lightweight materials.

Revenue and traffic continued to grow on all Zephyr motor trains and in 1941 they were reported to be as profitable as ever. For the year ended June 30, 1941, the "Pioneer Zephyr" showed per train-mile revenues of $1.10 as compared to per train-mile expenses of $0.52.

Diesel Motor Car Costs

The economies of diesel locomotives as compared to steam are generally known to be substantial. However, the savings are still greater when diesel engines of smaller size are employed in self-propelled cars.

When compared to the gas-electric, the diesel motor car is more economical due mainly to savings in fuel cost. In the cases studied, diesel fuel expenses per mile were from one-half to two-thirds less than gasoline costs.

The Seaboard Air Line Railroad's two diesel motor cars built in 1936 were found to be operating in the early part of 1949 for 47 per cent of the cost of running a substitute steam train.

The chief savings were in train fuel expense and power plant maintenance expense. These items alone accounted for 72 per cent of the difference.

The steam unit consisted of a Pacific-type locomotive, a mail-express car and one coach, which were equivalent to the power-mail-baggage cars and single trailer coaches of the motor trains. Both types of equipment were used on a round-trip run of 678 miles between Savannah, Ga., and Montgomery, Ala.

The ratio of diesel motor car to steam train costs was quite similar on the Baltimore and Ohio in 1948. While the Seaboard's total cost figures were higher than the B&O's, due to the inclusion of more items, the individual mechanical and crew expenses for both lines tallied closely.

The Baltimore and Ohio trains studied were numbers 40 and 41 running between Beardstown and Flora, Illinois, a distance of 154 miles. During the period covered by the study, the motor car train compiled 44,330 train-miles and the steam train 4,560 miles.

Operating savings were also shown by the Milwaukee Road's two large 1000-hp. diesel-electric motor cars. During November, 1948, these cars were operating at an average out-of-pocket cost of 92 cents per train-mile, or 70 per cent of steam costs. Used in branch-line service in Wisconsin and Montana, each of these power-mail-baggage cars regularly hauled two standard trailer cars.

Cost comparisons between small diesel motor cars and trains propelled by diesel locomotives are scarce, due to the fact that very few lines exist where one of these types can be satisfactorily substituted for the other.

An attempt was made, however, by the Great Northern to present a fairly representative analysis of the operating costs of these two types of equipment. The results show the costs of operating a 300-hp. motor car to be about 55 per cent of those of a 2000-hp. diesel-locomotive train. On a train-mile basis, the motor car cost $0.58 as against $1.04 for the large diesel train. It must be noted, however, that the trains studied were operated over different routes under dissimilar operating conditions. The periods in which the studies for each type were made were approximately the same—March, 1948, for the motor car, and May, 1948, for the diesel-locomotive train.

An analysis based on a system average was reported by the Northern Pacific for the year ended December 31, 1948. The average cost of operating thirteen gas and diesel-electric motor cars was reported to be $0.57 per train-mile, while the average cost of operating both steam and diesel locomotive-propelled trains was given as $2.04 per train-mile.

Diesel Motor Train Costs in 1949

In the spring of 1949, there were eight principal diesel motor trains of the "Zephyr type" in operation. All of these except one were 14 years old or more.

An analysis of cost data from the railroads reveals that in 1949, all of these lightweight, high-speed motor trains were operating at out-of-pocket costs considerably below those for trains propelled by locomotives.

In all except one case, the cost comparisons were made of units of equivalent capacity operating in the same service. In the case of the "Rebel," cost data of a larger train were used in the absence of data for a smaller, more comparable unit.

Again it should be noted that, due to differences in operating conditions and in methods of determining "out-of-pocket" costs, these cost statements do not indicate the relative efficiency of one railroad over another, but rather the relative economy of one type of equipment over another.

One of the largest operators of lightweight, diesel motor trains in 1948 was the Burlington with three such units in service. In a study made early in 1949, the average cost of operating these trains was found to be 64 per cent of the cost of a comparable steam train, and 75 per cent of the cost of operating a diesel-locomotive train.

The chief economies of the Zephyr trains were fuel savings and reduced maintenance expense, both for the power plant and the cars. The savings on fuel alone amounted to 10 cents a mile, and similar savings were obtained in train expenses.

The Gulf, Mobile and Ohio reported that in February, 1949, one of their

four-car "Rebel" diesel motor trains was costing $0.93 per mile to operate as against an operating cost of $1.78 per mile for their locomotive propelled "Gulf Coast Rebel."

The cost analyses have shown "crew wages" as one consolidated figure in order to simplify the comparisons. In a cost statement received from the Boston and Maine comparing their "Cheshire" diesel motor train with trains propelled by locomotives, crew expenses were shown in detail.

Like the other motor trains analyzed, the "Cheshire" costs show a distinct saving in fuel and maintenance expense. Both of these savings were largely the result of the smaller diesel power plant and lightweight construction which were incorporated in all of these units.

On the basis of the above costs, the 3-car articulated motor train cost 38 per cent less to operate than the diesel-locomotive train, and 55 per cent less than the steam train.

In 1949 the "Cheshire" was running between Boston and White River Junction, Vt., a distance of 153 miles, making six round trips per week.

The last motor train cost analysis to be considered is that of the New York, New Haven and Hartford's "Comet" which was $2091 as compared to a cost of $3638 for a steam locomotive and two coaches.

On a train-mile basis, the out-of-pocket expenses to run the "Comet" were 57 per cent of those for the steam train.

Summary

The foregoing facts clearly demonstrate the economy of rail motor cars and small diesel motor trains. Comparative cost data recorded over the period 1914-49, without exception, attest the operating economy of this type of equipment. Briefly, the facts are these:

1. Early American gas-electric motor cars cut the out-of-pocket cost of steam passenger train operation approximately in half.
2. Railcars in other countries before World War II were operating at 25 to 50 per cent of the cost of running an equivalent steam train.
3. In the United States a number of lightweight, diesel motor trains were introduced in the 1930's which increased traffic and cut operating costs substantially. These high-speed, "Zephyr-type" trains were run at approximately one-half the cost of comparable steam trains, and at the same time provided superior service.
4. Numerous old-fashioned gas-electric motor car trains on U. S. railroads in 1948 were operating at costs 50 to 60 per cent less than those for comparable steam trains. Similar savings were shown by small diesel-powered motor cars.
5. In early 1949 there were eight "Zephyr-type" diesel motor trains in service, almost all of which were in their fourteenth year of operation. Generally speaking, these units were running at costs ranging from 45 to 65 per cent of the cost of equivalent steam trains, and from 60 to 75 per cent of the cost of comparable trains propelled by diesel locomotives.

The Problem of Railroad Passenger Service

In recent years the central problem of the railroads has been the inadequacy of net income in relation to revenues and capital investment. Probably the most vexing contributory problem has been the large annual loss from passenger service. "Passenger service" includes all allied services—mail, express, milk, baggage, and miscellaneous services—performed in conjunction with passenger train service, in addition to services performed directly for passengers.

Heavy Losses From Passenger Service

In 1948, the deficit from passenger service on Class I railroads reached an all-time peak of $559,950,000. This was a loss of over 1.5 million dollars per day. In the prewar years from 1936 through 1941 the net railway operating deficit in passenger service fluctuated between $226 million and $262 million. Following the profitable war years 1942-45, passenger service returned to the prewar deficit situation with a loss of $139.7 million in 1946.

The peak deficit in 1948 was more than twice the highest figure reported in the six prewar years 1936-41, and was $133.4 million above the 1947 passenger service deficit.

In contrast the net railway operating income from freight service in 1948 reached a high of $1,561,133,000. After deducting the passenger deficit, the total "net" from railway operations was $1.002 billion or approximately 35 per cent less than the "net" from freight service. This amounted to a rate of return on investment (after depreciation) of 4.38 per cent. However, had there been no passenger deficit in 1948, the rate of return on the net property investment of the railroads would have been over 6 per cent.

While operating revenues from passenger and allied services increased from $1.400 billion in 1947 to $1.435 billion in 1948, or 2.5 per cent, operating expenses for these services rose from $1.645 billion in 1947 to $1.828 billion in 1948 or 11.1 per cent. The increase in revenues was mainly due to fare increases which tended somewhat to offset the decline in passenger business during 1948.

Reports from twenty-seven large steam railroads for the year 1948 show a net railway operating deficit from passenger and allied services in every instance. It is noted that deficits ranged from $3.3 million for the Nickel Plate to $48.5 million for the New York Central. The total passenger service deficit of the twenty-seven roads comprises $431 million, or 77 per cent.

of the total Class I passenger deficit of $559.9 million in 1948. The same roads accounted for $1.203 billion, or 85 per cent of the $1.4 billion Class I revenues from passenger and allied services.

High-Speed Streamliners Show Profits

While railway passenger operations on the whole have been unprofitable, this is not so with a number of individual streamlined trains throughout the country. On many leading railroads, high-speed streamliners have shown substantial profits ever since their inception. Most of these modern diesel trains are well known to the public. They include the "Hiawathas" of the Milwaukee Road, the "Daylights" of the Southern Pacific, the Rock Island's "Rockets," the Illinois Central's "City of New Orleans," and many others.

Streamliners Few in Number

An examination of any railroad time table will show that the profitable, high-speed streamliners make up only a small portion of daily passenger train operations. The large majority of the daily runs are of the slow-speed, short-haul variety.

In November 1948, there were 119 different streamliners in regular service on the American railroads. This was less than one per cent of the 15,000 passenger trains operated daily by the same roads.

Problem of Suburban Service

The importance and extent of suburban rail travel has been increasing since 1940. In 1947, almost 50 per cent of all passengers carried by rail were commuters, and over 13 per cent of the total passenger-miles of Class I railroads were compiled by commuter services.

Unlike the railroad passenger business in general, commuter traffic continued to grow following the war. In 1946, the first postwar year, all railroad passenger travel was down 34 per cent from the 1944 high, but commuter business was up 9 per cent. Commutation services in 1946 accounted for 5.8 billion passenger-miles as compared to 5.3 billion in 1944.

The high point in commutation travel occurred in 1929 when 6.8 billion passenger-miles were compiled. Following 1929, a steady decline took place until the all-time low of 3.9 billion passenger-miles was reached in 1940. Beginning in 1941, commuter traffic went steadily upward reaching a 16-year high of over 6 billion passenger-miles in 1947.

Approximately 98 per cent of all commuter passengers carried on Class I railroads during 1946 were handled by the 19 leading "commuter" carrying railroads.

Suburban Service Deficits

While suburban traffic has been increasing since 1940, the reported annual deficits of many suburban lines have likewise been increasing. It is important to note that suburban service deficits are usually computed on the basis of fully allocated costs. The revenues of many suburban railroads considerably exceed the direct cost of suburban operations.

In 1948, the Long Island, largest U. S. commuter-carrier, reported a loss of $6,016,330 as compared with $3,996,000 in 1947 and $1,188,000 in 1946. In Chicago, the steam-powered Chicago and North Western reported a 1947 net suburban deficit of $2,195,222 as compared with a loss of $1,634,348 in 1946. In New England, the New Haven reported a 1947 deficit from its Old Colony division of $3,600,238. These three cases are indicative of the financial difficulties faced by most suburban railroads in the postwar period.

On the other hand, the Illinois Central multiple-unit suburban service, second largest U. S. commuter carrier, showed a profit during the years 1946-48. Computed on the basis of fully allocated costs, the Illinois Central reported net railway operating income from suburban service of $630,154 in 1946, and $74,194 in 1948.

One factor contributing toward suburban losses has been the high cost of doing business. On the C&NW the cost of labor, fuel and material in 1947 averaged 88 per cent higher than the corresponding figures for 1940. The largest percentage increase was shown by coal fuel which was 132 per cent above the 1940 figures.

The high cost of steam operation was likewise reflected in the New Haven's Old Colony passenger service results. The average revenue per train-mile in 1947 was $3.40 as compared with a fully allocated cost per train-mile of $5.93. Computed on a car-mile basis, the figures were $0.58 revenue against $1.03 full cost. Transportation expense alone amounted to $3.53 per train-mile and $0.61 per car-mile. Maintenance of equipment amounted to $1.15 per train-mile and $0.20 per car-mile. Thus, the Old Colony in 1947 ran an average fully allocated loss of $2.53 for every train-mile operated and suffered a loss of $0.13 per train-mile against transportation expenses alone.

Several fare adjustments were made during the period 1940-47 which partially offset rising expenses. However, commuter fares cannot be raised to any appreciable extent without reducing traffic volume. Taking the Central of New Jersey as an example, it was reported that a 16 per cent decline in traffic was suffered by that line after a 38 per cent increase in commutation fares.

Peak Load Problem

The primary cause of suburban losses is the poor utilization of equipment and personnel, during off-peak hours. Suburban railroads must be geared to meet the peak demand during the morning and evening rush hours, while during non-rush hours they only provide for a very low volume of traffic. As a result, a large majority of the crews and equipment are not utilized during off-peak hours, although the expense of maintaining them on a full-time basis must be incurred. Moreover, this basically uneconomical operation must be supported by fares which average less than those for intercity travel.

Inflexibility A Costly Item

An important factor adding to the high cost of providing suburban service is the lack of flexibility of locomotive-propelled trains. Since the amount of motive power used cannot be varied according to train size as on multiple-unit electric services, the costs of operating a one or two-car train

are practically the same as those for an eight or ten-car train.

The large number of relatively small trains operated on a normal weekday makes this an important cost item. In 1947 suburban trains on the Milwaukee Road varied in length from two to seven cars. Out of a total of 55 daily trains, 23, or 42 per cent, were operated with only two or three cars. During off-peak hours 78 per cent were trains of three cars or less, including one or more baggage coaches on practically all runs.

The Chicago and North Western's mid-day suburban operations followed a similar pattern. Train lengths on that line averaged slightly higher, but mid-day passenger traffic justified the operation of only one or two coaches in most instances.

Poor Frequency Another Deficiency

The poor schedule frequency of many suburban roads may be attributed to the high cost of steam operation. Frequent small trains throughout the low traffic hours are not economical when run with locomotives, even when they are filled to near capacity, which is the exception and not the rule.

The Illinois Central, through the use of flexible multiple-unit electric trains, is able to run frequent short trains throughout the day. Of a total of 469 trains operated on a normal weekday in 1948, 28 per cent were two-car and 43 per cent were four-car trains.

The I. C. in 1948 was providing ten-minute service during most of the day and better than two-minute service during rush hours. The C&NW equaled the train frequency of the I.C. during rush hours, but provided only hourly service during the remainder of the day.

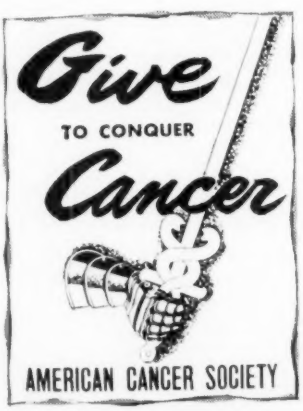
In 1925, a year before the Illinois Central suburban service was electrified, steam trains were carrying an average of 2 million passengers a month. In 1927, a year after electrification, the number had risen to 2.4 million per month. In 1947, the monthly volume was over 4.5 million passengers.

Car-miles operated were roughly the same before and after electrification, but the number of trains run each weekday increased by almost 20 per cent. Daily trains jumped from 398 in 1926 to 470 in 1927 with no increase in trackage.

The above figures indicate that after adopting multiple-unit electric motor trains, the Illinois Central began operating more daily trains of relatively shorter length. The most noticeable effect of this increase in train frequency was on off-peak travel. According to Mr. W. M. Vandersluis, an electric engineer for the I. C., the off-peak business increased materially after the motor cars were employed.

The Illinois Central also gained other advantages through the adoption of electric motor train equipment. The high servicing costs resulting from the necessity of keeping steam locomotives fired during standby periods were eliminated. The electric motor cars could be shut down completely when not in use.

The smoke nuisance, both to passengers and city dwellers, was done away with. The fact that motor cars could be stored and serviced like ordinary coaches removed the need for engine-houses and the daily journeys to and from them. Also, countless switching and turn-around operations were eliminated due to the fact that multiple-unit electric motor trains provide their own motive power and can be operated from either end. Lastly, the high rate of acceleration of these units enabled the Illinois Central to reduce its scheduled running time 10 to 24 per cent.



Summary

The problem of railroad passenger service losses may be largely attributed to the many unprofitable secondary passenger trains which are largely steam-powered. This applies to a large proportion of main-line, branch-line and suburban services. Significant facts revealed are the following:

1. In 1948, the deficit from passenger service on Class I railroads was $559.9 million, an all-time high.
2. In contrast to the overall unprofitability of rail passenger service were a number of individual streamlined trains which were quite profitable. However, these trains were relatively few in number.
3. The majority of daily passenger runs in 1948 and 1949 were of the slow-speed, short-haul variety. Analysis of three representative railroads showed that by far the majority of passenger trains averaged only 25 to 35 m.p.h. and were on runs of 200 miles distance or less. These secondary passenger trains have been the chief money-losers on most American railroads.
4. In 1947, suburban rail service attained an importance greater than in any previous year since the widespread introduction of the automobile and motor bus. Nevertheless, it was still a highly unprofitable operation for most suburban carriers.
5. Suburban rail losses have mainly resulted from poor utilization of equipment and personnel during off-peak hours. The high cost of steam operation, inflexibility of locomotive-propelled equipment, and poor schedule frequency have likewise contributed to suburban railroad losses.

Conclusions

It is hardly necessary to explain that railroad passenger service is essential to the national economy and for the national defense. There is every evidence that the public welfare requires efficient and economical railroad passenger transportation. According to

the 62nd Annual Report of the Interstate Commerce Commission, the railroads in 1947 carried 60 per cent of the intercity common carrier passenger traffic as compared with 30 per cent by bus, 8 per cent by air and 2 per cent by water. In the same year, suburban rail service attained an importance greater than in any previous year since the widespread introduction of the automobile and the motor bus.

Modern high-speed streamlined trains propelled by diesel locomotives which have been reported profitable on a number of runs throughout the country are relatively few in number, representing less than one per cent of the 15,000 passenger trains operated daily by U. S. railroads. The 1.5 million dollar daily loss from passenger service in 1948 must be attributed mainly to the large majority of U. S. passenger trains on relatively short haul local runs.

Obviously, abandonment of passenger train service is not the solution, although it may be advisable in a few local areas where the automobile and bus provide distinctly superior service. The great opportunity for increasing the profitability of railroad passenger service lies in the application of modern equipment in those areas where potentially the railroad offers faster and more attractive service to the traveler than private automobile, bus or airplane.

Flexible, versatile, multiple-unit diesel motor trains can be utilized to effectively reduce passenger service losses on both suburban and main-line runs. Stated otherwise, this equipment opens the way to better, faster and cheaper travel for the countless trips that are too long for bus or automobile, and too short for airplanes.

Several advantages of the motor train are due to its superior traction dynamics. Because it has a much larger proportion of total weight on drivers, and because it is usually built with a higher horsepower per ton of train weight, the motor train can accelerate more rapidly and attain a higher maximum speed than an equivalent train with a steam or diesel locomotive.

As an example of this principle, take the articulated diesel-electric motor train design consisting of three cars mounted on four trucks. Since two of the four trucks are powered with electric traction motors and support the weight of two diesel engines mounted in the center car, the adhesion weight on the driving wheels is approximately 60 per cent of total weight of the train. In contrast, a train consisting of a locomotive and three standard passenger cars seldom exceeds 30 per cent of total train weight on drivers, and the proportion of adhesion weight to total train weight is further decreased as more cars are added. Furthermore, as more cars are added, the horsepower-weight ratio of a locomotive-propelled train decreases, thereby reducing not only the rate of acceleration but also the balanced speed.

Due to its constant horsepower-weight and adhesion weight ratios the motor train retains its high rate of acceleration and balanced speed, whether used as a single three-car train or when coupled together in multiples thereof (a 12-car train for example). Moreover, the motor train, with its balanced distribution of weight, is easier on track and roadway than a train with locomotive.

In addition to its efficient traction dynamics, the "MU" diesel motor train offers the great economy of flexibility. By decentralization of internal combustion power and the use of remote electric controls, the motor train can flexibly adjust its capacity to variations in traffic demands. Equipment, fuel and manpower can be more closely geared to traffic fluctuations than in the case of trains propelled by steam or diesel locomotives. For example, an MU motor train commencing its operation as a long series of units, may be conveniently broken up into smaller units at junctions for a variety of destinations. Conversely, small motor trains originating at a variety of destinations, may be readily coupled together at junction points and brought into the central terminal as a single train.

The flexibility of the MU motor train is also illustrated by the case of a long motor train departing from a major city for another major city at 100 to 200 miles distance and a group of minor destinations beyond. Upon arrival at the major destination, a portion of the train is uncoupled and continues on to serve more distant places. The remaining section of the motor train operated in reverse direction returns promptly to the original terminal. After one or more additional trips between the major cities, the second section again unites with the long-distance section for the final return trip. Thus, greatly improved service is attained through maximum utilization of equipment and personnel which are closely geared to traffic requirements.

By means of dual-purpose streamlined motor trains, the poorly utilized suburban train of the past can become the suburban-mainline streamliner, or "suburba-liner", of the future. Suburban trains averaging less than 100 miles per day in the past can attain as much as 400 miles per day by being interchangeable in suburban and through service. Experience has shown that even on electrified multiple-unit suburban services, approximately two-thirds of the equipment is idle except during morning and evening rush hours. The remaining third of the equipment is used for frequent service throughout the day. By means of the dual-purpose diesel motor train, the two-thirds of suburban equipment normally idle throughout most of the day and night can be profitably utilized in frequent through train service within a radius of approximately 200 miles of major cities. Thus, the multiple-unit diesel motor train affords even greater flexibility and economy than the multiple-unit electric passenger train which must be confined to electrified lines.

While much attention has been devoted to the possibility of diesel motor trains solving the suburban problem, it must be emphasized that the suburban problem represents only a very small fraction of the railroad passenger service problem. The greatest opportunity for the use of multiple-unit diesel motor trains lies in all those services, largely on the main lines, where the potential traffic is insufficient to support large trains propelled by locomotives. 85 per cent of the daily passenger trains operated by three representative Class I railroads were on

(*Continued on page 80*)

Factors Affecting Cylinder and Ring Wear of Diesel Engines

—by Dr. Tracy C. Jarrett*—

THE RAPID growth and advancement in the diesel engine field today has brought about many problems which are always present with progress. Time has proven that none of the problems are insurmountable and such is the case with the diesel engine of today, and more particularly the diesels used on railroads. With the increased demand for more horsepower, greater speed and less weight per horsepower, involving higher mean effective pressures and higher operating temperatures, the problem of increased cylinder wear, ring wear and breakage became more pronounced.

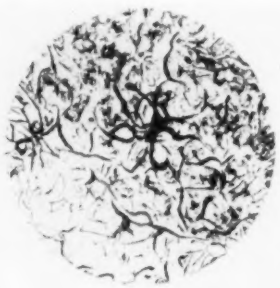
Some of the factors involved in overcoming the increased cylinder and ring wear, etc., are new ring designs such as narrow faced rings, proper tension and in some cases higher tensions than those previously used, ring shape, greater resistance to breakage, and improved wear properties. The problem of increasing ring life has gone through many steps to achieve what we believe to be a satisfactory piston ring material. This problem goes back several years, and to clarify and properly present its progress, a brief history of the development of this material seems to be in order at this time.

History

Piston rings, as of six to eight years ago, were made from a good grade of gray cast iron. This material had satisfactory physical properties and performed satisfactorily for the demands placed upon it at that time. As the demands became greater, and this first occurred in the aircraft field, it was necessary to develop, within a short period of time, an alloy which would resist breakage. As a first step, a ring material statically cast containing alloys and heat treated, served this purpose quite well, from the viewpoint of breakage, for one make of aircraft engine. In manufacturing rings from this material for other aircraft engines, the material was not satisfactory because of difficulty in controlling physical properties and its low toughness characteristics.

The next step to improve this material was the development of an iron of the malleable type, statically cast. The problems encountered in manufacturing this type of ring appeared too great, from a foundry and casting standpoint, and a new approach was taken. It was observed, although the strength of the individual castings was increased from approximately 35,000 to well over 100,000 psi., we still were not free from rink breakage and a new means of evaluating ring properties was introduced, namely the impact test or the measure of toughness. At the strength increased, the impact or toughness in static cast materials did not increase in proportion to the high strength and consequently, it was felt this property, too, should increase strength if we were to get the most out of our rings.

Research work was begun on centrifugally casting piston rings and the first material produced possessed a very high strength and a high toughness factor. This material was highly

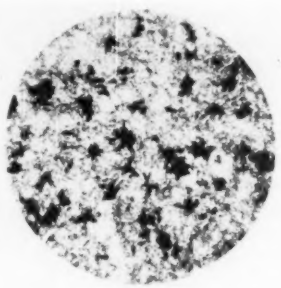


A

STANDARD IRON STATICALLY CAST

B

ALLOYED MATERIAL STATICALLY CAST



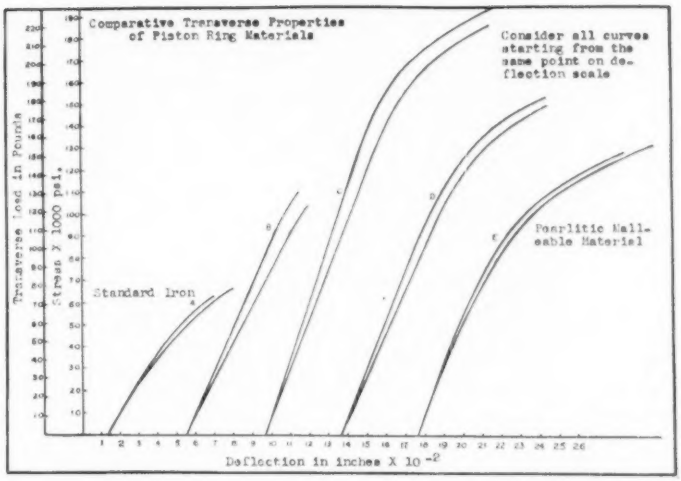
C

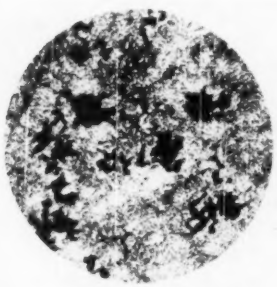
HIGHLY ALLOYED MATERIAL CENTRIFUGALLY CAST

*Manager of Engineering and Research, Metal Products Div., Koppers Co., Inc. Abstract of the paper prepared at the DEMA-Sun Symposium held in Philadelphia, Dec. 1949.

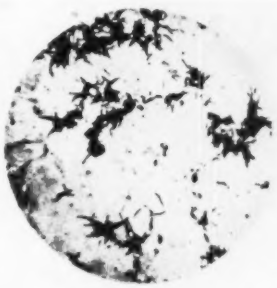
alloyed, and although the strength and toughness were high, the wear resistance could be improved. Since the centrifugally cast material was cast white and fully heat treated, the possibilities of improving the wear resistance and maintaining good physical properties, was well within the realm of possibility.

The next approach to improving mechanical properties and wear was in removing a portion of the alloys and changing the heat treatment. This change resulted in a new alloy designated as Material D. By doing this, the size of the graphite was increased many times; however, the tensile strength and toughness factor were lowered, but the wear resistance was increased considerably. To further improve this material, the alloys were completely removed and the heat treatment changed so as to bring about a pearlitic matrix instead of a tempered martensite as was formerly obtained in Material D. The graphite size, irrespective of the matrix, remained large. The wear resistance of this material was not only improved over the previous alloy, but was better than that obtained with the standard individually cast gray iron.


Comparative Transverse Properties of Piston Ring Materials
Consider all curves starting from the same point on deflection scale
Transverse load in Pounds
Stress X 1000 psi.
Standard Iron
Pearlitic Malleable Material
Deflection in inches X 10 -2



D
LOW ALLOYED MATERIAL CENTRIFUGALLY CAST



E
UNALLOYED K-SPUN MATERIAL CENTRIFUGALLY CAST

The gray iron individually cast, containing a flake graphite with long stringers in a fine pearlitic matrix, imparts to the material many planes of weakness, which contribute to low toughness or impact value. The centrifugally cast material, possessing large nodular graphite with the absence of stringers, allows the material to have greater toughness or impact resistance because of the absence of the many planes of weakness. The large graphite, in addition to increasing the strength and toughness, increases the wear resistance of the material as well. It has been found through research that it is necessary to have this type of structure to produce a material with both high strength and high impact values. In addition, the pearlite of the centrifugally cast material is much coarser than that obtained from individually cast gray iron, and it has been proved that coarse pearlite is desirable for improved wear resistance.

The research work done on ring materials has brought out many important points. Although it is desirable in a piston ring to have the yield and ultimate strengths quite close together to have the best spring properties, the factor of toughness must not be overlooked. In the case of individually cast gray or high strength irons, the ultimate and yield points were extremely close together, resulting in a more or less brittle material, or one with little or no toughness. The individually cast material had little or no elongation and consequently, it would break rather rather easily when slightly overstressed. The centrifugally cast material, which has elongation between 2 and 5 per cent does have a high toughness factor. The yield point, although well above the stress limits applying to piston rings, does not approach the ultimate to such an extent that embrittleness occurs. It is this factor, uncovered in research work, which will continue to play an important part in the ultimate performance of a piston ring.

Performance Improvements

This new material is helping to improve ring life in many ways.

1. Ring breakage is being reduced to a minimum.
2. Unit pressures are now obtained far exceeding those hoped for in the past, without bringing about ring distortion.
3. It is permitting engine designers to use narrow width rings, the trend for several years, but which has been slowed up considerably by the lack of a material which would permit the

engine designer to go as far as he felt was desired.

With a material having good physical and wear resistance properties, it is possible to design characteristics into the ring in the form of tension, circularity, and shape, which will cause the ring to function better, reduce blowby, ring breakage, etc., which are vital factors in the reducing of cylinder wear and ring life.

In many cases, although the ring material has excellent wear resistance, other factors such as abrasion or corrosion often cause abnormal wear. To resist these conditions and to retard the abnormal wear, porous chrome was applied to the cylinder contacting surface of the ring.

The chrome plate is deposited electrolytically to a thickness of around 0.004 in to 0.006 in., after which the outside surface is made porous. The porous O.D. of the surface acts as a lubricant-carrying medium during the critical breaking-in period of the engine. This surface stays on for several hours, after which it wears off and the hard surface of the chromium then comes directly in contact with the cylinder wall. Dr. Denfield, has this to say about break-in mediums, "A piston ring with a hard chromium-plated contact surface will not reach normal running conditions as quickly as an ordinary piston ring. For this reason, the use of a 'Break-in film' was considered. But we believe that a better way was found when, by use of proper methods, the chromium layer was made finely porous."** In many types of engines the overall ring life was increased as much as 80 per cent which not only means the top ring but the other rings as well. This observation was confirmed by work done in Germany by Dr. Denfield which stated, "By using a chromium plated ring for the first ring, the wear of all rings is reduced to approximately 1/4 to 1/3. At the same time the astounding observation is made that the wear of the cylinder walls is also decreased to about half".

COMPARATIVE PHYSICAL PROPERTIES OF PISTON RING MATERIALS

	MATERIAL	Hardness Min.	Hardness Max.	Tensile Strength P.S.I. Minimum	Transverse Modulus of Elasticity P.S.I. Minimum	Ized Impact In.-Lbs. Minimum
A	Standard Iron Statically Cast	95Rb	105Rb	41,000	11.0×10^6	2.5 - 3.5
B	Alloyed Material Statically Cast	29Rc	38Rc	65,000	17.2×10^6	4.1 - 6.2
C	High Alloyed Material Centrifugally Cast	30Rc	37Rc	95,000	32.0×10^6	18 - 20
D	Low Alloyed Material Centrifugally Cast	24Rc	30Rc	88,000	20.0×10^6	12 - 18
E	Unalloyed Pearlitic Malleable Material Centrifugally Cast	95Rb	105Rb	70,000	18.6×10^6	8 - 12

Conclusions

Experimental and field work showed that when using a porous chrome ring, complete cylinder and ring contact, or seating-in as is commonly called, was established within a few hours due to we believe what is the action of the porous chrome on the cylinder walls. In observing the cylinder walls after a few hours of operation, they had the appearance of being slightly honed, which is believed was beneficial in bringing about a quick seat both on the rings and cylinder. This quick seat obviously prevented wear caused by blowby on hot gases going by the rings and causing boundary lubrication. It also must be brought to mind that the difference of the hardness between the chrome surface and most cylinder surfaces is very great, for example the ordinary cast iron liners have a Brinell hardness of approximately 200 to 300, whereas chrome is near 1000 to 12000. This difference in hardness and materials in itself would tend to eliminate the possibility of metal-to-metal seizure.

The use of the chrome ring in conjunction with a new metal of high strength makes it possible for the engine designers of today to go forth with his designs and achieve that which he has never been able to do before. The high strength metal will allow him to reduce his face widths and increase his tensions, and the chrome plated ring will aid as an extra safety measure in reducing cylinder and ring wear.

**Denfield, Job "Porous Chrome Plated Piston Rings" (Report of the Research Institute of the Goetze Works, Inc., Burscheid near Cologne).*

POROUS CHROME FIELD TESTS

Typical Cylinder Wear Rates Using Cast Iron and Porous Chrome Rings

	Engine Make	Model	Bore (in.)	Cylinder Wear per 1,000 Miles (in.) Cast Iron Ring	Cylinder Wear per 1,000 Miles (in.) Porous Chrome Ring	% Decrease In Wear
	GMC Diesel	471	4 1/4	0.00028	0.000067	76.1
	GMC Diesel	471	4 1/4	0.00031	0.000048	84.5
				Cylinder Wear per 100,000 Miles (in.)		Total Miles
A	EM Diesel	567	8 1/2		0.0006	355,752
B	EM Diesel	567	8 1/2		0.0007	822,779
C	EM Diesel	567	8 1/2	0.003		131,983
D	EM Diesel	567	8 1/2	0.002		100,833
E	EM Diesel	567	8 1/2	0.0022		138,786
F	EM Diesel	567	8 1/2	0.0022		353,063

Locating trouble made easy with new
Trouble Spotter

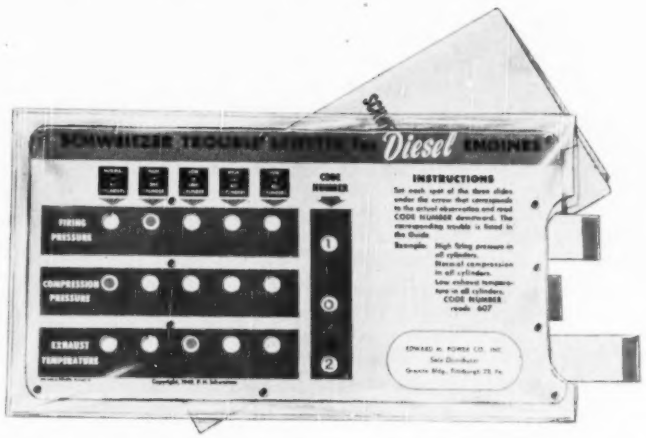
YEARS ago, the writer was engaged in the somewhat exasperating job of making engines for boat and car racing give more horsepower at higher speeds and still stay together. When a cranky "souped-up" engine wouldn't start, it was no comfort to hear the stock comment of an associate, "It's easy, it can only be spark or gas". True enough but—oh, brother, what a number of conditions and combinations can be causing the trouble.

It is like that in a diesel and on some of the elusive troubles, a comprehensive knowledge of diesels plus a lot of experience is required to pin them down. The newcomer to the field could well do with a comprehensive guide for spotting trouble and even the oldtimer, who isn't too proud, will appreciate one, if only as a good check list.

Well, we have news for both of these fellows: There is a new comprehensive and authoritative—as well as convenient "Trouble Spotter" available. It is the work of Professor P. H. Schweitzer, Pennsylvania State College, in conjunction with a number of diesel engine experts.

Working on the basis of "it can only be spark or gas" adapted to the diesel, three fundamental references are used. These are the firing pressures, compression pressures and exhaust temperatures. Abnormal engine conditions will generally show up in one or more of these and it will be noted that these are all values obtained from common engine instrumentation.

Because of the interrelation of these three indices of engine condition, the slide rule portion of the trouble spotter is provided with a slide for each that must be set opposite one of five pointers across the top. The pointers are labeled as follows: Normal in all Cylinders; High in one Cylinder; Low in one Cylinder; High in all Cylinders; Low in all Cylinders. It can be seen that these indicate a normal condition, show whether the condition is local



or generalized, and the direction of the abnormality.

After the three indexes of engine performance have been set, a code number appears in a column at the right. Now, the second part of the spotter comes into play. This is a booklet that explains the procedure of diagnosis and has two groups of data designed to convert the code number into the required trouble analysis. The first of these is a numerical sequence of code numbers correlated with the probable trouble and a "trouble number".

Realizing that the same symptoms might arise from a variety of troubles, Professor Schweitzer added another feature in this listing to help pin down the particular difficulty. This column is headed, "Supplementary Observation" and includes such items as would be evident without instrumentation. The code number together with this observation permits determination of the probable trouble and the appropriate number.

The second major portion of the booklet lists the trouble numbers in order, with the probable trouble, and then correlates the most likely defect. Short explanatory paragraphs help to clarify the difficulty.

Let's run through one analysis see how it goes. Firing and compression pressures are both normal with exhaust temperatures high in all cylinders. Setting the slides gives Code 006. Supplementary observation is "Smoky Exhaust". Four probable troubles are listed: overload; over-lubrication; crankcase dilution; high exhaust back pressure. Each has an associated trouble number.

Following through on "Overload" we look up Trouble No. T216. The trouble is cited as "excessive fuel in all cylinders" with the probable defects listed as: "engine overloaded"; and "defective governor or linkage". An explanatory paragraph suggests a simple method of differentiation.

The use of separate booklet for the listing of all the various troubles that might be indicated by the instrumentation, plus the supplementary observations, allows a much more comprehensive coverage than would be possible if attempt was made to place them all on the slide rule.

While practically all of the troubles normally encountered are covered, there will always be a few of a "freak" nature that will arise to plague the operator. For this reason, sound judgment and careful observation must always be used to supplement the information provided by the spotter. With this combination, the trouble spotter can be mighty useful.

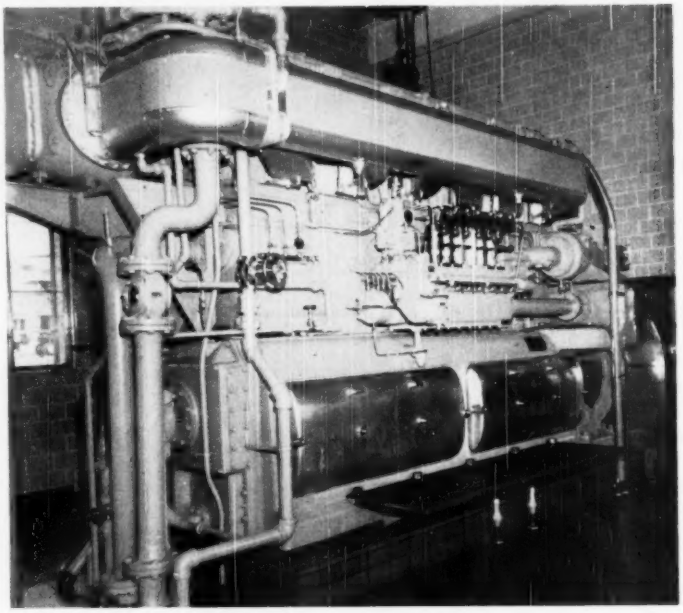
Diesels Power the World's Largest Pipe Line

Already the largest pipe line system in the world, the Great Lakes Pipe Line Company will soon operate 60,000 hp. of diesel pumping capacity through more than 4500 miles of pipe line by the end of the year. The company has standardized on diesel power teamed with centrifugal pumps to give efficient, economical operation on this mammoth system.

WHEN the current phase of the expansion program of the Great Lakes Pipe Line Company is completed at the end of the year, the firm will be firmly established as the largest pipe line company in the world, a position it holds even now. The expansion and modernization program calls for the operation of approximately 60,000 hp. of diesel pumping capacity through more than 4500 miles of pipe lines.

The organization, operation, and maintenance of such a tremendous project naturally presents many difficult and unusual problems. The success of the Great Lakes Pipe Line Company in meeting and solving these problems is a tribute to both the pipe line personnel and the equipment they operate.

Stretching through nine states with major ends of the line located at Tulsa, Ponca City, Chicago, Minneapolis, and Grand Forks, North Dakota, eighteen originating shippers are served at fourteen terminals including such intermediate locations as Kansas City, Des Moines, Omaha and Sioux City. The installed power will permit delivery of over 8,000,000 gallons of fuel oil and gasoline daily—or in the language of the pipe line industry—210,000 barrels per day.



One of the Alco pumping engines. A separate (and very attractive) engine room is provided.

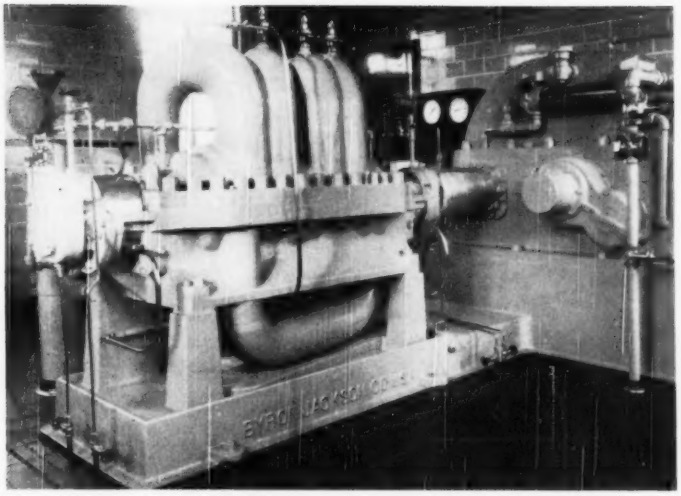
History

Great Lakes was organized in 1930 to transport gasoline. In 1939 distillate shipments were first accepted and it now transports several grades of refined petroleum products. It is owned by eight producing and refining companies, and serves twice that number. The original line from Tulsa to Minneapolis, and from Des Moines to Chicago, was entirely equipped with diesel driven pumps. The engines were heavy, low speed units of 375 hp. driving equally cumbersome reciprocating pumps. An 8 in. pipe line ran to Des Moines and a 6 in. line ran beyond from Des Moines to Chicago. Gradual expansion of the system during the decade 1930 to 1940 saw the addition of similar diesel pumping units and, reflecting a then new trend in pipe line thinking, the installation of some electrically driven centrifugal pumps.

During the war years, with expansion impossible, all of the equipment was operated at full load every available minute. The tremendous boom in post war petroleum usage—brought about by high business levels, pent-up demand, and labor difficulties in the coal industry—made immediate expansion and modernization imperative. The increased market for products to the northwest of the original main line justified the construction of a new line in this direction, originating at Kansas City. It was also necessary to enlarge the existing system.

Expansion and Modernization

Due to the age and obsolescence of existing pumping equipment and the high cost and relative unavailability of repair parts, it was decided to replace all of this equipment on major line sections. In its stead, based on the experience of the company and others, Great Lakes chose main line pumps of the centrifugal type. Reduc-



The other side of the dividing wall showing the speed increaser and the multi-stage centrifugal pump driven by the engine shown earlier.

tion of space requirements, ease of maintenance, reduction of inter-facial mixing of different products, slightly lower cost, and the virtual elimination of pressure surges were all factors in this decision.

Experience also emphasized the advantage of standardizing all main pumping units. Diesel power was selected in preference to electric motors because of the knowledge that during a large part of each month operation would not be at maximum capacity, and demand charges are based on peak power usage. However, electric motor equipment did seem feasible in some locations. The Kansas City and Des Moines stations which already contained electric motor driven equipment remained unchanged.

Reduced through-put periods, occasioned by characteristics of the petroleum market, as well as the temporary existence of greater pumping capacity to the north out of Kansas City than in from the south, plus other normal causes, would also have meant the use of non-standard pumps in the interest of keeping efficiency loss to a minimum. This is due to the fact that motor operation is necessarily a constant speed proposition, and discharge pressure, through-put and power requirements are all a pre-set function of pump speed.

The only efficient capacity of an electrically driven pump is full load. To obtain efficiency at intermediate delivery, it is necessary to divide the total desired through-put into small increments so that variable delivery is at least approached. This generally means a compromise between probable desired levels of through-put and the more practical considerations of pump station cost involved in manifolding, building and pump sets—and loss of standardization of pumps. The only economical solution is usually a combination of three pumps, two of 40 per cent of line capacity, and one pump of 20 per cent the so-called "2½ pump" design.

On the other hand, with one standard diesel unit, any condition can be met—from zero to rated capacity in infinite steps—all at high efficiency since speed can be varied. The electric pipe line also loses direct control over power supply and cost. A substation or high line outage at any point on the pipe line from any individual electric source would cause a reduction of through-put by about 40 per cent on the whole line—a very serious matter.

Prime Mover Selection

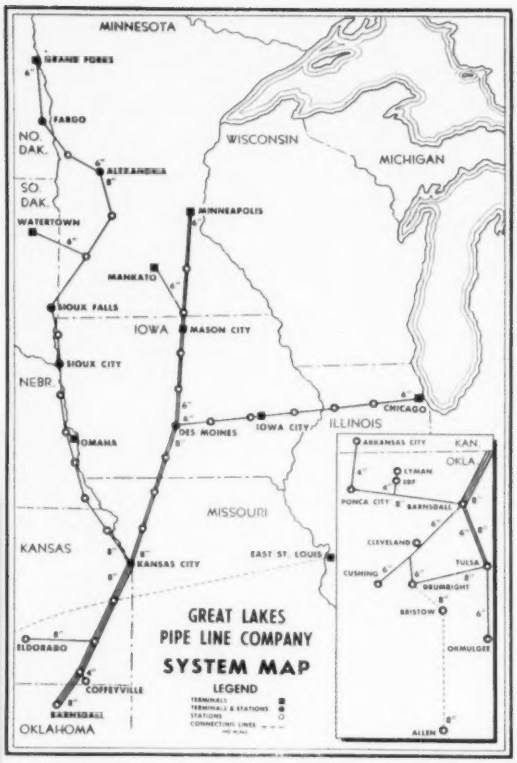
Choice of the type of diesel was a new departure, based in part on the limited but successful application to continuous pipe line service of medium-speed, 500 to 700 rpm., engines and in part on the amazing record compiled by this type of unit in war time and industrial service.

The main reason for the choice, however, was the crying need for a unit of this type wherever centrifugal pumps were indicated. Reduced space and weight, ease of maintenance, reduction of required overhaul time, availability and low cost of parts, reduced cost of both prime mover and accessories (principally the speed increaser and couplings), a wide speed range and high over-all efficiency were attractive incentives to the management and operating personnel of the pipe line.

Efficient application of space and weight, ease of maintenance, and reduced overhaul time are characteristics of all major equipment on the line. Great Lakes management like that of other alert transportation companies, is well aware of the tremendous importance of maintaining a high use factor on its equipment.

The final standard pumping unit as installed during the 1946-1947 expansion consisted of an American Locomotive Model 6-12½ x 13-T diesel engine, Falk speed increaser and couplings, and Byron Jackson multistage pump. The unit was rated 810 hp. at 600 engine rpm., 3500 pump rpm., and a delivery of 30,000 bbls. per day. The complete unit occupies little more space than did the old 375 hp. engine alone. The same building that housed these old units will contain almost four times as much capacity in the modern Alco powered equipment. No standby pumping capacity was provided. The faith in the main equipment has been well substantiated; unscheduled shutdowns have been practically nil.

Cooling apparatus, both for lube oil and jacket water, is also supplied by Alco and is of the vertical shell and tube type mounted in pits out of the way during operating periods. All connections are at the top and the tube bundles can be removed from this end for inspection, repair, or replacement with minimum effort. Filtering and starting equipment and all other accessories are likewise compact and out of the way but are accessible for quick, easy maintenance.



A map illustrating the scope of the pipeline system. Inset shows the network at the source.

Expansion in 1946-47

The 1946-47 expansion consisted of a new 8-inch line through Kansas City from Tulsa to Alexandria, Minnesota, and a 6-inch line on up to Grand Forks, plus the re-powering of all existing main line stations from Tulsa to Minneapolis. The capacity of the system was increased approximately 50 per cent.

Standard diesel pumping sets were installed on parallel pipelines, three per station south of Kansas City, two per station northeast, and in single units northwest of the lines' hub. Each station naturally is in series with the one "up-stream" and the one "down-stream" from it, and in normal operation the pumps are controlled by suction pressure on the main incoming pipe line.

Primary stations, of which there were 20 prior to the 1946-47 expansion and 34 afterwards, were spaced approximately every 50 miles. Fourteen stations were new, modern installations; the others remodeled. Altogether, 31 of the new Alco powered pumping units were installed.

Further Expansion

The rapid growth of the petroleum market created an emergency almost immediately and the increased demand resulted in the installation of temporary secondary stations on one main line from the south and all main lines to the north of Kansas City. These secondary stations were temporary installations to tide the system over until pipe and equipment for increased capacity could be obtained.

The secondary units were war surplus aircraft engines derated to about one-third of their designed horsepower. Because they were temporary, of low cost, and not designed with what a stationary diesel engineer would call "ease of maintenance" in mind, complete spare engines were provided. The units generally were scrapped if they failed in service or had worked the major portion of their useful life. When overhaul was indicated, the complete engine was removed and a replacement installed in its place.

Since these units have no further significance to this report, suffice it to say that results were surprisingly good. The engines averaged a useful life of about 1000 to 1500 hours and, in isolated cases, over 3000 hours.

The second phase of the modernization program is now in progress. All of the secondary stations are to be removed from the existing lines and a new 12 in. line laid from Tulsa and Ponca City to Minneapolis, with a second 12 in. line from Kansas City to Sioux Falls, South Dakota. There will be three new diesel stations. Twelve existing diesel stations and the two electric ones are to be enlarged. Thirty-three new pumping units will be installed, twenty-nine of them diesel and four electric.

This line will utilize existing pumping stations but two new pumps will operate in series in each station as well as between them. They will be operated on 100 mile spacing. This is important in that it leaves room for future expansion by the relatively inexpensive investment in pumping sets installed in the remaining, existing alternate stations not now to be enlarged. This will make all operation on a 50 mile basis, and a 45 per cent increase in the capacity of the new line will be possible.

All of the new diesel engines will also be American Locomotive 12½ x 13-T models. The only variation is that a large number of the new engines will be eight-cylinder rather than six-cylinder models. Practically all wearing parts excepting crankshaft and camshaft, however, are interchangeable between the two sizes. Thus, the aim of standardization is almost a reality. The Alco engine, which supplied two-thirds of all power at the end of 1947, will supply about 85 per cent in 1951.

Diesel Engines

The Alco diesels in the system are four cycle, 12½ by 13 in. bore and

stroke. All are turbocharged by the Buchi system. Nominal ratings are 810 hp. for the six-cylinder model and 1080 hp. for the eight-cylinder at 600 rpm. Both ratings are at a bmep. of 111.8 psi. Pistons are aluminum with a shrunk-on ring belt of the same material, fusion welded. This forms a unique system of oil cooling amounting to a two tube, five pass oil cooler with oil passages directly between each compression ring and the nearest part of the hot piston crown. The ring belt can be replaced when the ring grooves are worn, thus making the piston as good as new.

The engines operate on diesel fuel oil which is one of the products they pump through the pipe line. The increasing availability of natural gas at station sites has resulted in the conversion of two of the existing units to dual fuel operation. One of these, at Tulsa, has been operating on natural gas for almost two years. Others are scheduled for conversion and 17 of the 29 new engines to be installed will be factory-equipped for this fuel system.

Features of the Alco dual fuel design are the individual, piston type, gas metering valves which time and meter gas admission to each cylinder, and automatic control of pilot fuel injection.

The gas metering feature is said to make it impossible to get a free flow of gas through the cylinder regardless of any mechanical failure which can be assumed. It prevents an over-supply of gas on any power stroke even if the engine slows down due to overload or other extreme conditions. As a consequence, the exact balance between cylinders is positively assured at all loads. In addition, it is easily adjustable for varying quality or pressure of gas supply.

In regard to the second feature of the dual fuel design, the automatic fuel supply cam increases the pilot oil below about one-third engine load where gas fuel to air ratios become unreliably lean. The pilot oil is constant from about one-third load to overload. It has not been necessary to increase pilot oil at overload to avoid detonation, because the Alco engine does not suffer from detonation within the power range regardless of ambient temperature. It is impossible except by intentional readjustment of limits to load the engine over 110 per cent of rated capacity whether running at full diesel, minimum pilot, or at some intermediate ratio. This is an important safety protection for engine, supercharger and electrical equipment.

These safety features of the Alco design are particularly attractive to the pipe line industry, which like any other transportation business is dependent on continuity of operation for its success.

Factors Obviating Standardization

Although standardization of pumping units and stations is continually approached, variable factors like these resist complete standardization obstinately:

1. The availability or lack of natural gas up and down the line.
2. Weather conditions and accompanying problems of operation, maintenance and equipment at one location as compared to another.
3. Variations in market demand and character cause unforeseeable adjustments in pumping schedules at different sites, and consequently in operating loads and hours.
4. Better accessibility of some stations to both transportation and major repair facilities.

Fortunately, the terrain traversed is relatively level throughout the system; running around 1000 ft. in elevation.

In addition to routine problems of diesel maintenance and the factors named, there also exists the problem of uniform, quick reaction to difficulties arising on any one of four main segments, the ends of which are respectively 300, 450, 550 and 750 miles distant from the main office of the line located in Kansas City, Mo. This involves in part the education or re-education of personnel in the operation and care of the modern equipment in use. There is also the consideration that no standby pumping capacity is provided at any point on the system. And behind all of this is the incentive and constant awareness of the fact that the unscheduled shutdown of any single engine will cause a loss of through-put of between 12,000 and 25,000 bbls. per day.

Maintenance Program

Uniformity of maintenance practices and equipment is primarily achieved through the division of the pipe line into three areas, each under the direction of an area supervisor. These men are responsible for the prompt and efficient action of all station crews in putting prescribed maintenance programs into effect. They supervise this work and must see to it that proper tools and materials are on hand at the right time. Each manages an area warehouse where spares in excess of normal station requirements or capacities are stored and certain sub-assemblies are overhauled.

Information of area mechanics is correlated and interpreted on a system-wide basis by the operating and engineering departments of Great Lakes together with equipment manufacturers, where necessary. Recommendations as to changes or additions to maintenance practices are made and in turn translated into action.

Basically, all maintenance is carried out on a regular schedule and is preventive rather than corrective in intent—this having paid huge dividends over the company's entire operating history. Reports of the results of regular inspections and overhauls are forwarded monthly to the central office, their contents noted and recorded on machinery history cards. The report itself indicates the nature of the work accomplished on a monthly, quarterly, semi-annual and annual basis.

The monthly inspection requires six to eight hours; the quarterly maintenance routine is allotted approximately ten hours. The semi-annual routine requires twelve to fifteen hours; and once a year a forty to fifty hour major overhaul is undertaken. Overhaul involves heads, valves, pistons, bearings, fuel pumps and nozzles, turbocharger, attached pumps and all other engine assemblies.

In addition to this maintenance report, daily and monthly operating logs

are kept and from these a master ledger is compiled at the central office from which one can immediately determine total engine hours, major repairs, hours on a given part, hours between lube oil changes, lube consumption, and other pertinent information. From experience it has become possible with the use of the accumulated information to establish trends and probable life in hours of practically all parts of the complete unit. This has proved most helpful in the planning of work to be accomplished and the logistics of material and tool supply.

Since prevention of failure and reduction of "down time" are the unceasing aim of the maintenance program, no attempt has been made to keep parts inventory and usage to an absolute, irreducible minimum. Instead it has been found profitable to stock complete sub-assemblies such as cylinder heads with all valves installed, piston and connecting rod assemblies, spare turbochargers, governors and pumps. Many portions of these items will never wear out and in some cases are not even subject to wear, but they pay for themselves by virtue of being a component of some assembly in which another part requires regular renewal or cleaning.

The reduction in down time made possible by the bodily replacement of these and similar assemblies yields an attractive return in through-put. The removed assemblies are cleaned, reconditioned, and placed back in stock —either station or area—for use at the next overhaul. No attempt is made to squeeze the last few hours' operation out of a worn part that has been removed. Naturally, material that can be reworked either in the field or factory is recovered.

The quantity and nature of stocked assemblies is the result of careful and thorough analysis of the reports mentioned above in conjunction with possible savings in down time and assembly cost. The manufacturer plays his part in this routine by maintaining a unit exchange and repair and return service on certain common sub-assemblies normally beyond the scope of station or division repair facilities; for example, injection equipment and cylinder heads.

Tools have come in for careful scrutiny as a result of the maintenance procedure. The day of the pipe wrench, a set of open ends, a sledge, and a miscellany of hardware store tools (all usually applied with the generous assistance of a length of 2 in. pipe) has disappeared. The advent of modern equipment and the increasing demand for quick and efficient methods of overhaul have resulted in the distribution and use of the latest in socket sets, universal joints, power hand tools, and torque wrenches. Special hand tools purchased from the equipment manufacturers are also in evidence.

Supplementing these are certain other fixtures utilized for the systematic storage, cleaning, and moving of heavy assemblies. Among these are supporting racks for piston and rod, and work tables for cylinder heads, each especially designed by maintenance personnel. Portable cleaning tanks and cylinder boring and honing machines are supplied. A special liner pulling and installing device has been designed and is in use.

A comparison of man hours for overhauls using a different sequence of operations has resulted in the selection of a standard sequence which fits routine conditions yet is flexible enough to allow for unforeseen contingencies. Experiments have determined the best distribution of experienced men and less skilled helpers among the three crews that carry the round-the-clock overhaul schedule.

All personnel are trained or retrained to the proper operating and maintenance practices recommended by manufacturers and Great Lakes. Typical examples of re-training have been the long struggle to prove the merit of higher operating temperatures and the proof that a bearing scraper is practically an obsolete tool. Precision parts and workmanship, higher rotated speeds, bmep's, temperatures, and pressures are new to the older mechanics. Special emphasis is laid on the importance of planning—assuring that proper tools and materials, each in good condition, are on hand before overhaul starts; laying out work for succeeding shifts; and fitting special operations into the overhaul pattern with minimum disturbance.

Through the organization and use of these uniform standardized procedures, scheduled down time has been cut in half over the three years' experience with the new equipment. Down time, never excessive by common standards, is now scheduled at approximately 160 hours per year, including the eight monthly, two quarterly, one semi-annual, and one annual major overhaul. This is indeed an excellent and enviable record.

Proving the soundness of the overall maintenance program is the fact that out of 592,896 total accumulated engine hours at the end of November, 1949, only 95½ hours have been lost due to unscheduled shutdowns—including all failures regardless of the particular piece of equipment involved.

Conclusion

Average use factor over the 3½ years of installed time on the pumping equipment has been 85 per cent, with many stations running between 95 and 96 per cent. The latter stations are generally the ones to the south of Kansas City or just to the northeast which are less likely to be affected by changes to product movement schedules, or equipment maintenance periods near the end of the line. It is noteworthy in this connection that use factor has steadily increased over the period. In the last half of 1946 the average use factor was 56 per cent. In 1947, the first full calendar year of operation, the average jumped to 73.4 per cent and grew further to 83.5 per cent in 1948. In 1949 the average unit ran 88.9 per cent of all the hours of the year. Half of the Alco diesel pumping sets installed operated over 95 per cent of the time and the record unit set a pace of 98.8 per cent use factor.

These are the results of sound organization, good management, a far-sighted maintenance program, and intelligent operating procedures. The outstanding record achieved is the explanation for the continued expansion and prosperity of the Great Lakes Pipe Line in a highly competitive business.

Bosch Opens New York Headquarters

WITH personnel in attendance from most of its sales and service agencies in the Metropolitan area as well as from engine manufacturer and fleet operator customers, American Bosch held, on April 6th, a formal opening of its new headquarters in New York, 601 West 51st Street.

The modern two-story building at that location, which has just been completed, will house both the American Bosch Branch Office, formerly situated at 1819 Broadway, and the Company's recently established New York Service Sales Division. Offices occupy the second floor. The first floor is devoted entirely to mechanical service facilities for American Bosch products and to stockroom and counter space.

According to manager Joseph A. Foss, the New York Service Sales Division has been established to handle both the sales and service of American Bosch automotive, electrical, and diesel fuel injection products in Manhattan and surrounding area comprising the Counties of Bronx, Dutchess, Orange, Putnam, Rockland, Sullivan, Ulster and Westchester in New York and the Counties of Fairfield, Middlesex and New Haven in Connecticut.

Top to bottom—the service shop, exterior of the new headquarters, and offices.

With an accent on high quality and efficient service, the service shop contains the most modern repair tools and test equipment, many of them designed and built by American Bosch to provide factory standards of service. They include the company's recently developed fuel injection calibrating stand, TSE 3400, which has the capacity to test and calibrate with extreme accuracy the larger size railroad-type fuel injection pumps.

Service personnel of the new division are well qualified to render expert repair service on American Bosch products, having had much practical experience in that capacity, and the entire floor layout from initial product cleaning area to counter and well-stocked bins has been designed for the utmost in practicability and efficiency.

With the New York Service Sales Division acting as a distributor for American Bosch products in the area previously mentioned, in addition to its repair and service operations, the company expects to obtain much first-hand information on the sales and service of its products which will prove helpful not only to the company directly but also to its entire system of agencies throughout the country.

According to Mr. Donald P. Hess, president, the company, by closely observing the new operation, hopes to amass much practical information on such subjects as the accurate determination of necessary inventories; the most effective sales and distribution techniques; the establishment of proper operating costs and procedures; the development of new service techniques in the rapidly expanding field of diesel fuel injection; and on other related operations. "Thus", said Mr. Hess, "by living with the problems of our distributors and doing something about them, we expect results to be particularly advantageous not only to our distributors and ourselves, but to our customers and the ever increasing number of users of American Bosch equipment".

Company executives and directors besides Mr. Hess who were present at the opening included Joseph E. Ridder, chairman of the Board, Herbert C. Guterman, president of Arma Corporation, and Foster N. Perry, American Bosch vice-president in charge of Manufacturers Sales.

Laboratory Analysis aids

Southern Pacific's Servicing Program

Streamlined facilities and scientific analysis take the guesswork out of the preventative maintenance program and improve locomotive availability factors.

Locomotive entering the service track facilities of the Southern Pacific. The refueling island is on the right with sand towers and wash rack in the background.

by James Joseph

WHEN a diesel locomotive begins the hour and thirty minute servicing treatment at Southern Pacific's service tracks in the Los Angeles yards, it gets all the attention a prima donna would at the beauty parlor.

Combined with a compact and efficient servicing facility — geared to grease, refuel, and wash each diesel locomotive after each run —is a highly scientific chemical analysis of water and lube oil for the purpose of diagnosing the running pains of every diesel engine in the locomotive.

The diagnostic instrument is the spectrograph, newest and most far-reaching of chemical analyzers. Southern Pacific is one of the first railroads to use the instrument as a part of routine maintenance.

Suppose we follow a locomotive through the service track and watch the operation. Few other facilities compare in diesel locomotive "know-how" and efficiency.

Twin service tracks, with concrete slab walks between, house four complete sets of fueling, watering and lubricating pumps. In an 8-hr. shift, from four to six locomotives — some of them with 3 units, a total of 6 engines — are serviced and sent out on the road. In an average 24-hour period, 16 locomotives will have been serviced on the 365-ft. long pits.

Briefly, the service area is equipped for quick back-to-service routine maintenance and end-of-the-run checkups. For anything more serious, the locomotive is run into Southern Pacific's new shops, adjacent to the service area.

The service rack has one aim: To reservice the locomotive and get it back on the road in the least possible time. At times, reservicing has been completed in less than 45 minutes. The service facility's layout is responsible for this speed.

The two 365-ft. service tracks are separated by the concrete runway, upon which are the service facilities that deliver zeolite treated water for the steam generators of passenger units; raw city water for toilet tanks and for cleaning; treated distilled water for diesel radiators; and diesel fuel. These pumps are grouped to service four locomotive units simultaneously. Meanwhile, as fueling progresses, an overhead sand-tower fills each unit's 16 cu. ft. cap. sand box.

Fuel oil is stored in a 10,000-bbl. tank that receives its oil from tank cars. While being unloaded the oil is pumped through a bank of *Michiana* filters. Before the units are refueled, the oil is filtered a second time.

Included in the servicing treatment is a good washing. As the locomotive moves through the washing bay, water is sprayed all over it under pressure. Big rotating brushes scrub off the stubborn dirt.

Probably the single most important servicing function takes place almost as soon as the locomotive reaches the service area. It is then that a 4-oz. sample of fuel oil and radiator water is taken from each diesel engine. Each sample, marked to correspond with the engine from which it came, is rushed to the nearby laboratory. This

is the heart of the preventative maintenance program, and one of the most fully equipped and comprehensive laboratories in railroad maintenance.

The oil samples, once rushed to the labs, are put in the *Zietfuschs Kinematic Viscosimeter*, a research instrument, that can run eight viscosity samples every 20 minutes. Lab facilities, like the service track, operate 24-hours a day.

An average day sees 200 viscosity tests completed. About 200 water determination tests are also run daily to check the inhibitor concentration and hardness. If hard water is detected the lab has specific instructions: The cooling system must be drained if the hardness exceeds 3 grains per gallon.

There is a 1200-gal. tank for storage of the zeolite treated water for the steam generators and similar facilities for the raw and distilled engine cooling water. There is no such thing as watering stations along the tracks saying that "they thought" they put in treated or distilled water. The hard water tests in the laboratory provide the evidence, one way or the other. If a radiator had to be drained up the line and hard water was used, it is drained in the service area before any harm can be done.

Water also enters into the lube oil tests. If the percentage of water in the lubricating oil is found to be above 0.5, the source of water contamination must be found and corrected. Also, the crankcase and filter box must be drained and the lube oil filters changed.

Besides these tests, approximately 15 acid or neutralization numbers, ash tests, and precipitation numbers are run daily.

In checking lubricating oil, if dilution by fuel is between 0.5 to 2.5 per cent, the source of fuel dilution must be found and the cause corrected. If over 2.5 per cent, the same procedure is followed and in addition, the crankcase must be drained.

Getting back to water testing if there is from a "trace" to 0.5 per cent of oil present in the cooling water, an effort is made to find the oil leak and the system must be flushed and refilled with treated water. Over 0.5 per cent oil dilution requires that the oil leak *must* be found, corrected, and the system flushed and refilled with treated water.

All these lab checks require a total of but 30 minutes. This means that approximately a half hour after the 4-oz. engine samples arrive in the lab, a diagnosis is sent to the service yard indicating authoritatively the action to be taken. In this, the responsibility rests with C. C. Mugford, ass't chief chemist of the Los Angeles branch laboratory.

This brings us to the most elaborate and newest of testing instruments — the spectrograph. Suppose we have a look at this piece of laboratory equipment and see how it directly affects Southern Pacific's service maintenance.

The spectrograph itself is an expensive instrument, some models costing up to $45,000. Southern Pacific was able to buy a 20-year old research model at bargain prices, reworked it, and has put it to daily use.

For many years spectrographs were thought to be purely research instruments; their practical applications were not fully realized. Now the instrument as used by Southern Pacific is scheduled to become its most important instrument in diesel trouble-shooting.

In brief, the spectrograph takes a sample of ash obtained by burning off all the oil from a lube oil sample, and then further dehydrating the remaining residue in a high temperature furnace. The ash itself is composed of (1) oxidation products of the various inhibitors and additives, most of them added by the oil processor (2) dirt and (3) particles resulting from engine wear. The latter is the chief concern of the instrument.

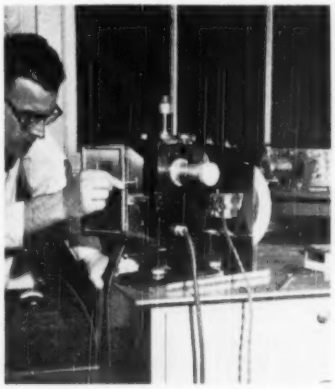
The residue sample taken from the high temperature furnace, is ground into fine powder and placed in a small pure-carbon, closed-end tube.

This carbon container is then placed between the spectrograph's electrodes, and subjected to a 200-volt, 14-amp. arc. Arc temperatures exceed 6000 deg. F.

The arc's electric field causes the powdered residue to give off light waves. These pass through a 2500-line-to-the-inch grid which spreads out

Samples of fuel oil, lube oil, and radiator water are taken from each engine after every run.

Making a viscosity test on lube oil taken from one of the locomotive engines.



C. C. Mugford, assistant chief chemist, making a spectrographic analysis of a sample of lube oil residue.

each light frequency given off. The light waves register on highly sensitive 35-mm. film. The various light waves — representing the frequencies of the chemical components of the residue — are spread out on the film, in characteristic lines, identifying and indicating how much of each chemical component the sample contains.

The resultant spectrum is then projected upon a screen and further spread-out to facilitate qualitative and quantitative analysis of the sample.

Suppose, for example, that the spectrum lines before us on the screen are very heavy near the frequency zone which denotes the presence of silver. By setting up standards, the lab men know just how much silver might be expected in the lube oil of an average, good-condition diesel engine running under normal conditions. But suppose our spectrum shows an abnormally heavy silver-zone spectrum line. Immediately the lab technicians, knowing that the engine's wrist pin bushings are made of silver, diagnose the trouble as excessive wrist pin bushing wear. This is reported to service tracks.

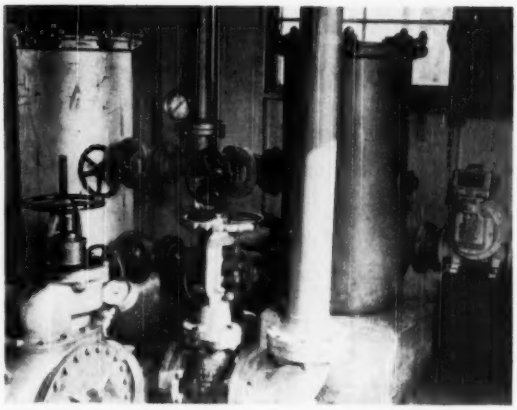
By correlating the amounts of various metals with previously determined norms for known periods of operation, it is possible to spot any abnormalities. Knowledge of the materials used in the various engine parts then permits the localization of the source of these components and serves as a clue in locating incipient troubles.

"By this spectrograph," confirms chemist Mugford, "we can predict engine failure 10,000 miles away." The spectrograph is sensitive to 1 part in a million — which means that the slightest wear of engine components shows up almost from the moment that it begins.

Once a satisfactory "normal" standard has been calibrated — the degree of wear can also be predicted. The lab keeps a periodic analysis of samples from each diesel engine, can predict wear trends at a glance.

Perhaps purchase of a $45,000 instrument might seem excessive, but Mr. Mugford has proved that the savings is well worth the investment.

Here are the savings realized by laboratory analysis based on six locomotives (three units each totaling 36 diesel engines) which came up for routine 30,000-mile oil drain. In the usual maintenance schedule each of the 36 engines would be drained. Applying this mileage (indicating hours of operation) to each of the 36 engines, they could normally be expected to run a total 1,080,000 oil miles before draining. Yet, a check in December, 1949, showed that these same engines had totaled 5,000,000 oil miles before a change — representing a lube oil savings of $35,000. And this, according to Mr. Mugford, is even too low because some had been drained earlier and did not have as great a total oil mileage as possible. Continuation of the oil in service beyond what are considered normal drain periods is possible with safety only due to the careful analysis and action on their interpretation.



Interior of the fuel oil pump house. Fuel is metered as it flows into the diesels. The Michiana filters shown here filter the fuel as it comes from the tank cars into the storage tanks and again as the fuel flows into the diesels.

Additional savings were found in 400,000-mile inspections with wear found to be very low. This is attributed directly to careful chemical analysis, the diagnosing of trouble before it happened.

Of 72 liners pulled on these engines, 67 were within the allowable tolerances and were replaced. Five were discarded for defects not associated with wear i.e. sand holes and breakage, etc.

None had to be removed because of wear. The manufacturer of the liners told the S. P. labs that this was probably the lowest wear rate in the U. S.

Some "oldtimers" may still argue that they can tell by feel, smell, or by their own "secret" method all about oil contamination without benefit of more scientific means of determining oil condition. To this, Mr. Mugford has only to point to some of the viscosity tests to show how small percentages of fuel dilution, undetectable at ambient temperatures, will make a No. 40 oil act like one of much lower viscosity rating when at normal engine operating temperatures.

The Southern Pacific uses Standard Oil Company of California's RPM No. 40 having an approximate viscosity rating of 1100 seconds at 100 deg. F. Remembering that the human fingers cannot detect much difference in temperatures above 90-100 deg. F, take a look at these viscosity figures.

At 90 *deg. F.*	1600 *seconds*
At 100 *deg. F.*	1100 *seconds*
At 130 *deg. F.*	400 *seconds*

Thus, with a temperature variation of 40 deg. F, viscosity dropped from 1600 to 400 seconds. The viscosity of a No. 20 oil is approximately 333 seconds at 100 deg. F. Therefore, in a temperature range hard to manually estimate, a 30 deg. F. error in temperature estimation would make a No. 40 oil appear to have the same viscosity as a No. 20 oil. This example serves to show the difficulty that our "oldtimer" will have in determining the fuel dilution present in the oil or the viscosity of good oil, for that matter. Locomotive engines require the heavier oil for proper lubrication and if such guesswork as mentioned above were to be used serious damage to the engine could occur.

With a complete diagnosis of engine trouble flashed back to the service tracks within half-an-hour, there's no guesswork at Southern Pacific.

Mighty Mower Reduces Saplings to Sawdust

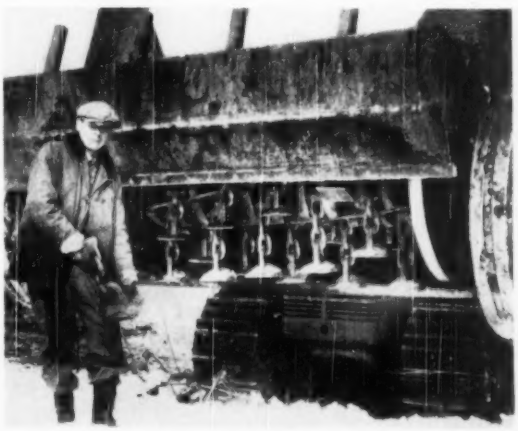
In 1940 when Mr. Harold Swertfeger began experimenting with a machine for clearing brush, he little realized that a successor to that first machine would one day be in great demand by utility companies, railroads and construction contractors. But today his machine, which is called the "Bushwacker", is accepted as being the first successful mechanical method for clearing access lanes to utility lines. Further it is expected to find acceptance on such clearance projects as building sites, airports, firebreaks, dam sites, highway, railroad and canal right-of-ways and grazing land reclamation.

The "Bushwacker" has demonstrated its amazing ability to completely obliterate every trace of vegetation including trees up to eight inches in diameter. In a single pass it literally disintegrates all brush, vines and undergrowth leaving in its wake only fragmented evidence of former growth. During recent tests the Bushwacker cleared one acre that was about 70 per cent elm, varying in trunk diameter from one-half inch to eight inches and with a mean of approximately three and one-half inches. The remaining 30 per cent consisted of hickory, maple, ash and wild apple with an undergrowth of hazel, thorn apple, wild rose and blackberry briars.

While photographers snapped the action and prospective buyers watched, the Bushwacker cleaned up that acre in one hour and twenty-four minutes at a total cost of approximately $40.00. By old manual clearing methods this job would have required a total of 200 man hours at about $250.00.

The design of the Bushwacker, while unique, is quite simple. Its mowing and shredding action is achieved by 20 steel "flails" that rotate at a peripheral speed of 11,550 fpm. (130 mph.). These flails weigh almost 20 pounds apiece and are attached by chains to a steel drum which revolves on the front of the machine at 1050 rpm. Power for the 'mighty mower' is a General Motors 2 cycle diesel engine with a rating of 168 hp. This engine was chosen because of its low weight to horsepower ratio and its ability to provide instantaneous response to changing loads. The entire mechanism is mounted on a standard crawler-type diesel tractor.

The Bushwacker is manufactured by American Steel Dredge Company, Inc.



Front view of the Bushwacker showing the bumper bar and some of the flails which cut the brush bent by the bumper.

British Diesels on Display

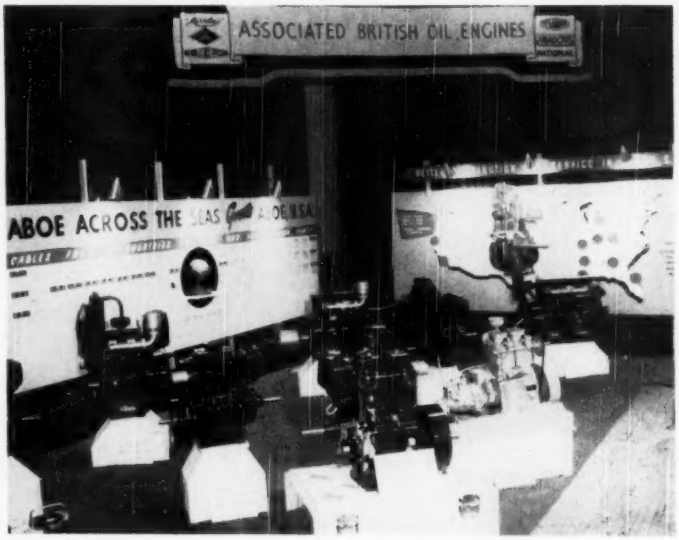
TIED IN with the recent British Automobile and Motor Cycle Show held at the Grand Central Palace, April 15-23, was a display of some British diesels. Size and types of engines were not restricted to those for transportational use, some stationary and marine models being included.

The display of British vehicles, the diesel engines and accessory equipment is part of the intensive British effort to sell goods in the American market and thus bridge the dollar gap. This effort has the sponsorship of our government in general and specifically of Economic Security Administrator Hoffman.

Sales techniques have been geared to the American market through the efforts of a team of 11 American business leaders who, under the sponsorship of the National Sales Executives and with the blessings of the ECA, recently visited Great Britain. This was at the invitation of the Incorporated Sales Managers Association of Great Britain.

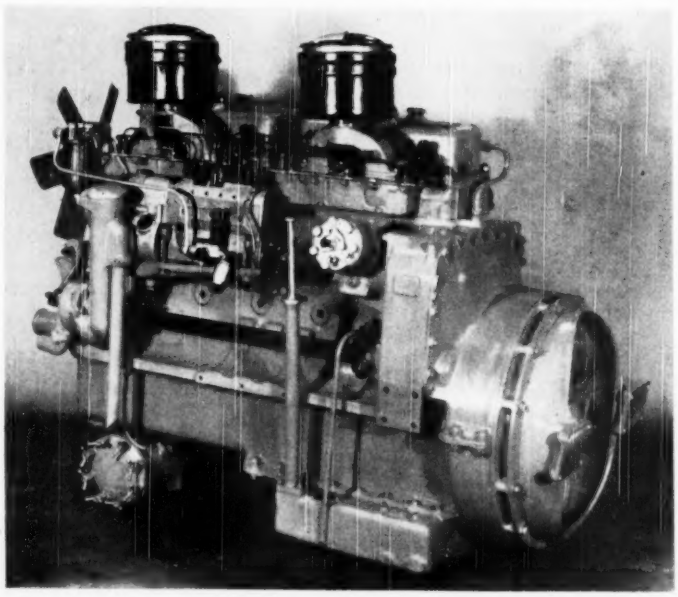
The success of such organization to obtain export business is indicated in figures quoted by one of the exhibitors, Associated British Oil Engines Inc. The British group, ABOE, Ltd., comprises Petters, Meadows, Petter-Fielding, McLaren, Mirrlees and National. The American company, ABOE, Inc., was formed in October, 1949, as a subsidiary of The Brush Electrical Engineering Company, Ltd.

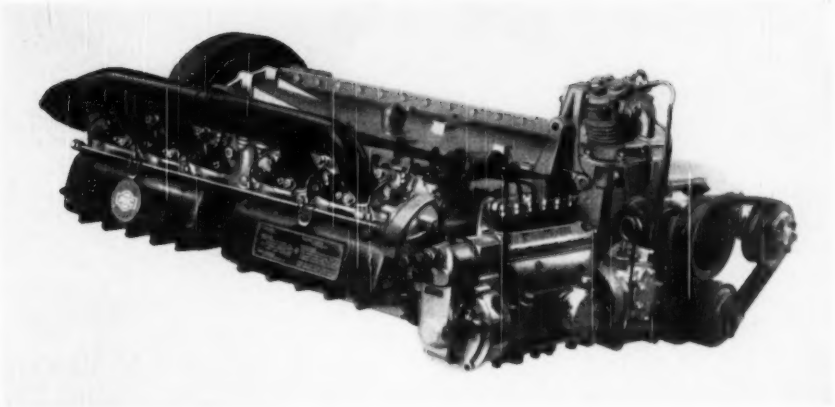
Achievements of the British group, whose engines are offered at fixed prices with fixed delivery dates, is shown by a comparison drawn between the years 1939 and 1949. Value of the total 1939 exports of the British diesel industry was 2,776,000 pounds sterling. Mirrlees, McLaren and Petter (members of the British group) exported to the value of 426,000 pounds sterling. Total British diesel exports in 1948 amounted to 16,761,000 pounds sterling. In 1949 the ABOE group accounted for 7,750,000 pounds sterling or over 18 times the value of their 1939 exports. This also represents about 45 per cent of the 1948 total British export and while the total is believed to be substantially larger for 1949, ABOE's share is claimed to be about 30 per cent.



The ABOE display at the British Automobile and Motor Cycle Show held last month. Models shown are Petter engines. Below, the Daimler diesel, one of the largest diesels used in Europe in buses.

An expressed aim of the British effort is to help make British-American trade self-sustaining. Ronimund Bissing, president of ABOE, Inc., commented as follows, "We are going to





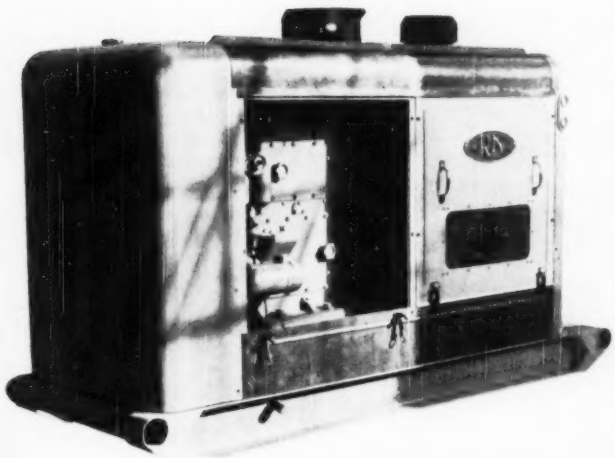
Horizontal 6-cylinder engine which AEC Ltd. had on exhibit at the show.

help American manufacturers in their export business by supplying, for payment in sterling, the diesel power units which they incorporate in their equipment. . . . In dollar scarce areas, we can contribute the power unit, for payment in sterling, thus enabling the American Manufacturer to sell a greater quantity of his equipment against the limited dollar budget of many countries than would otherwise be possible."

Another idea expressed is that the British engines marketed here will be for the most part in the smaller sizes where there is room for additional production.

The engines on display appeared to be well designed and of good workmanship. Those for transportational use included conventional vertical cylinder arrangements, as well as horizontal and vee types. Ratings are conservative and weights appear to be low. One engine, product of the Rover Company, Ltd., is rated 320 hp. and tips the scales at just under 1500 lb.

With the devaluation of the pound and other economic considerations, the British hold a definite price advantage. In addition, they are taking a realistic view of the parts and service situation that arises in the case of foreign products. The scope of the entire operation is greater and far better organized than any previous attempts to enter the American market. The domestic diesel industry will undoubtedly keep an eye on the progress made.



Russell Newbery self-contained "power pack" which is available in models from 38 to 170 bhp.

ASME Oil & GAS Power Division Annual Meeting

The 22nd annual meeting of the ASME Oil and Gas Power Division will be held in Baltimore the week of June 12. Important topics regarding internal combustion engines will be covered.

A great many interesting papers have been arranged for and will be presented at the meeting. A special Lecture Series on "Corrosion" has been scheduled as well as panel discussion on marine drives and the use of heavy fuels. Several inspection trips to plants in and around Baltimore are on the program, one of the most attractive being a trip by boat down Chesapeake Bay to the Naval Experiment Station at Annapolis.

The meeting dates are so scheduled as to make it convenient for educators to attend the conference without interference with their educational duties. The program will be distributed by the ASME in the near future and will be published in the June issue of *Diesel Power & Diesel Transportation.*

Test Report on the

Mitsubishi—Tokyo Engine

From the U. S. Naval Engineering Experiment Station at Annapolis, has come a report on tests conducted on a Mitsubishi engine, rated at 2000 bhp., at 1600 rpm. and a bmep. of 115 psi. The station's report, as yet incomplete, indicates that there are several factors in the design of the engine which bear further investigation.

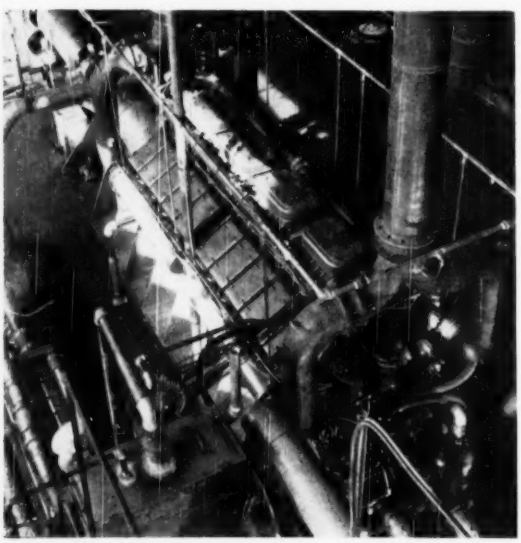
THE Naval Engineering Experiment Station is engaged in testing and evaluating all equipment and devices which comprise a ship's machinery plant with the exception of the main turbines and boilers. Specification testing is done to insure that the material the Navy purchases is of proper quality. Investigations are conducted to develop new or extended uses of equipment relating to machinery installations.

Six major laboratories and three special projects manned by approximately 1000 technical and shop personnel perform this work. Fields of investigation include internal combustion engines and gas turbine development, metallurgical and petroleum research, acoustic and vibration investigations, chemical and mechanical engineering, and welding methods and procedures.

The test of the Mitsubishi engine was conducted by the Internal Combustion Engine Laboratory in its Diesel Engine Branch. The head of the laboratory is W. F. Joachim and the Diesel Engine Branch is directed by W. G. Payne. The purpose of the test was to determine the suitability of the engine design, including weight, materials, and condition as received, for application to American engines; the power and economy performance at all loads and speeds from idling to full throttle and the maximum and continuous duty ratings. The engine rating, performance, and fuel economy tests are still to be completed, but the other phases of the test have been reported on and are presented here.

The Engine

The engine under test was a Mitsubishi, model ZC-707, 2-stroke diesel engine, vertical 60 degree V-type, 20 cylinder, 5.9 x 7.87 in. bore and stroke, with a reported maximum rating of 2000 bhp. at 1600 rpm. The engine employs a unit-type injector and uniflow scavenging with four Roots-type blowers. Manufactured by Mitsubishi-Tokyo, the engine is the prototype of this experimental design and, prior to its test in this country, had only 3 hours and 34 minutes of test operation. It was forwarded to this country by the Naval Technical Mission to Japan.



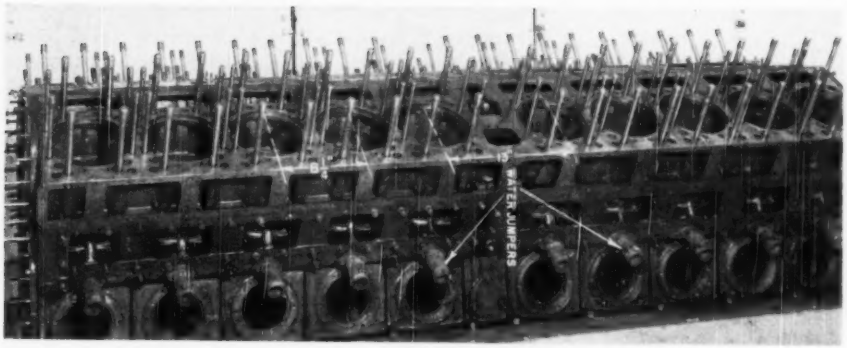
Overhead view of the Mitsubishi engine undergoing tests at the Naval Engineering Experiment Station. Note the compactness of the engine and the four blowers on top.

Noteworthy Parts

Results of the test showed that there were both good and bad features in the engine, one of the most startling features being its remarkably low weight per rated bhp. — 6.15 lbs. — as compared to a comparable American design which weighs about 17 lbs. per bhp. The Experiment Station report points out some of the good features of the design and these parts will be given a rather complete description since they will bear study by those interested in engine design.

The *crankshaft* is of forged steel and is made in two halves. The halves are identical with the exception of the length of spline on the end. The two halves are joined by a flanged coupling with ten 20-mm. body-bound bolts. There are twelve main bearing journals and ten crankpin bearing journals. The crankpins are evenly spaced every 36 deg. which gives an alternate firing of 12 and 24 deg. in a 60 deg. V-type engine. Counterweights are located on crank webs, 1, 2, 9, 10, 11, 12, 19, and 20.

The *main bearing journals* and the *crankpins* are hollow. Two 13/32-in.



Engine block which is 89 inches overall.

holes, 180 deg. apart, drilled in the main bearing journal, receive oil from the main bearing. Two 21/64-in. holes in the crankweb transmit oil to the hollow crankpin from the hollow main journal. Two 13/32-in. holes 180 deg. apart in the crankpin supply oil to the connecting rod bearing, piston pin, and for piston cooling. The crankshaft is polished all over and has no sharp corners. There is no flywheel on the engine except the vibration damper.

The *piston* and *cylinder liner* assemblies were found to have certain advantages which are noteworthy. The piston is of two piece construction. The trunk is tin-plated cast iron and the crown, including the compression ring belt, is steel with the top surface chromium plated. The two sections are doweled and are held together by six 10-mm. studs. The studs are pressed into the crown and pinned to prevent loosening.The bored holes in the piston pin bosses are fitted with bronze bushings for a conventional design. hollow steel, piston pin. The outer ends of the bore for the full floating piston are sealed with cast aluminum caps. The cooling oil chamber is not baffled. The oil is sprayed directly onto the flat underside of the crown and the heated oil overflows through two drain passages.

Each piston is fitted with four compression rings at the top and two oil control rings at the bottom. Compression rings. Nos. 1 and 3, from the top are gold seal, straight cut rings; No. 2 is a square face, straight cast iron ring; and No. 4 is similar to No. 2 ring except that it has a continuous groove around the upper outer edge. The oil-control rings are wide channel. straight cut, square face, two piece. cast iron rings with an expander behind each ring.

The cylinder liner is of cast iron. It is a wet-type liner with three double rows of seal rings to isolate the cooling water space from the crankcase and the scavenging air box. A brass ring is used under the top flanged edge. There are three rows of 19/64-in. diameter holes for scavenging air ports. The first row, from the top of the liner, has 40 holes that are cut horizontally at a 25 deg. angle to the cylinder centerline, the second row has 42 holes at a 10 deg. angle and the third row has 42 straight holes. The liner surface has a honed finish. The liners are positioned in the block by a dowel to provide alignment of slight cut-outs for the connecting rod.

The *timing and drive gears* are of interest because of the long addendum tooth profile. The tooth shape is understood to assure contact of two teeth at all times, so that unit loading is reduced and gear operation is more quiet. The intermediate gears are splined to steel shafts and are supported by single-row ball bearings. The crankshaft gears are splined to the crankshaft and are secured by locknuts.

The drive is from the crankshaft gear through a single idler gear to two camshaft gears, thence from the lefthand camshaft gear to the scavenging air blower drive pinion. The blower drive is through a spring-

Crankshaft showing the flanged coupling which connects the two sections of the shaft.

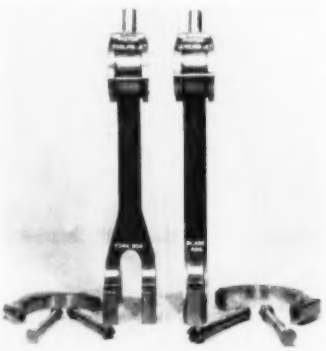
loaded, friction-plate, torsional vibration isolator, splined to the same shaft as the drive pinion, to a spring-pack type flexible coupling on a common shaft with the driving gear in the blower. These gears are identical on the two ends of the engine. On the forward end, the engine speed governor is driven from an internal spline at the end of one camshaft and the tachometer from a projecting stub shaft on the other. A gear with a ratchet drive to the front idler gear permits rotation of the engine with a hand crank.

The forward end of the crankshaft has a friction-type vibration damper, a timing disc, and a drive gear for the fuel transfer pumps, lubricating oil pressure pumps, and the fresh and salt water pressure pumps. The water pump drives are through idlers while the other pumps drive directly off of the crankshaft. On the aft end of the engine, the lubricating oil scavenging pumps drive from a gear integral with the power take-off gear hub at the end of the crankshaft.

A cast iron *exhaust manifold* with a sheet metal water jacket is provided for each group of five cylinders. The inside of the manifold is divided into three compartments running lengthwise. Two of the compartments each connect to the exhaust passages from two cylinders while the third compartment takes the exhaust from one cylinder. The open end of each manifold is fitted with a spherical joint to absorb vibration and to permit thermal expansion.

Instead of one large *blower*, this Japanese engine has four Roots-type blowers arranged in-line along the centerline of the engine. Two blowers are driven in tandem from each end of the engine. The vibration isolators which drive from each gear train are of the friction type. The inner hub has two friction plates splined to it. Between the friction plates are two spring-holder plates with twenty springs mounted in counter-bored spacing holes in them.

The two spring-holder plates are held in the internal teeth of a rim gear. Back plates are secured to each end of the rim gear. The springs force the



Piston assembly (above). The piston crown is chrome plated. (Below) Connecting rods.

holder outward and bind the friction plates against the back plates. Drive is from the hub, through friction between the friction plates and the spring-holder and back plates, and through the rim gear to the flexible coupling.

The flexible coupling between the vibration isolator and the first blower is of the spring-pack type. The drive from the rim gear of the coupling wedges two spring packs on the eccentric hub. Starting shock is taken up by relative movement between the rim gear and the eccentric hub. The splined shaft is a moderately loose fit in the hub to assist in installation of the blower. The shaft is pushed back out of its operating position, the blower is dropped vertically into the close-clearance position, and the shaft is pushed into operating position. A knob on the gear case cover holds the shaft in the operating position. A simple steel-disk coupling transmits the drive between the two blowers in tandem. Blower speed is 2.8 times crankshaft speed.

The *blower housing, end covers, and rotors* are cast aluminum alloy. The aluminum alloy in the rotors is supposed to have a lower coefficient of thermal expansion than the aluminum alloy in the blower housing and end covers, thus permitting smaller clearances at the lower delivery pressures and increasing blower efficiency. The two rotors each have three helical lobes. They are supported by single row ball bearings located in the end plates and are timed and driven by helical gears.

Lubrication of gears and bearings is by pressure from the auxiliary lubricating oil pump. Oil enters at the after end of the blowers, lubricates the bearings, and then goes through drilled passages in the blower housing to the driving end where it furnishes direct lubrication to the bearings and splash lubrication to the gears. The return oil drains by gravity from the bottom of the end-plate housings into a common header and into the rear gear train housing.

Other unusual and noteworthy features of this engine are the *camshaft assembly* and the *injector control*. The arrangement of the camshafts in four sections, each separately driven, decreases the driving force through each set of gears. It also decreases the length of shaft bearing alignment required.

The fuel cut-off lever at the operating end of each of the two injector control shafts along the engine permits cut-out of either bank of cylinders independently of the other bank. When operating at idle or very light loads for extended periods, engine performance can be improved by using only ten cylinders.

Advantages

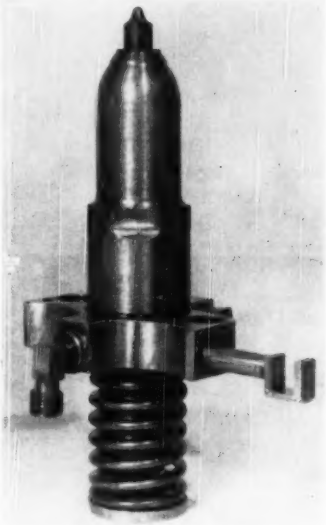
Because there are still several tests to be completed on the engine, no rec-

ommendations were made by the Experiment Station regarding the overall engine. As was mentioned previously, there were several parts of the engine which showed good engineering thinking in the design and those parts were described in considerable detail earlier in this article.

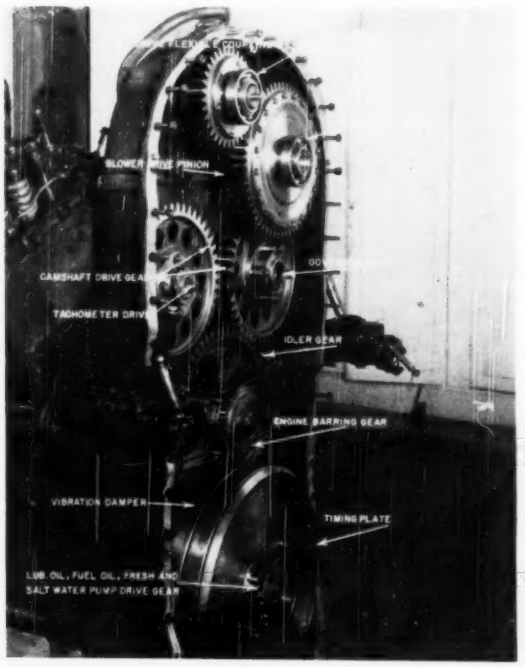
In order to highlight the advantages the Japanese firm gained by some of the modifications in the parts described previously, the reasons for including these parts in a "noteworthy" category will be given.

The construction of the crankshaft in two identical sections, with the exception of the machined length of the spline on the end, would simplify the forging and machining operations in manufacturing. Crankshaft replacement costs would be reduced in event of a journal failure since only one section of the crankshaft would have to be replaced. Although the use of a two piece crankshaft requires an additional main bearing and a connecting flange, the length of the engine was increased by only $4^3/_4$ in. The four piece construction of the main bearing assembly reduces the complexity of the design of the insert bearing.

The use of a conservative wet sleeve liner with a cast-in water space above and below the air box in the cylinder block, and of a chromium plated, steel crown, two piece piston with positive lubricating oil cooling, should reduce heat flow into the piston while providing good heat dissipation from the piston. The piston temperatures should be kept low. The reflective surface of the chromium plating on the crown of the piston should reduce the heat flow to the ring belt and help prevent sticking or sluggish compression rings. The additional strength of the steel ring belt should reduce wear of the ring grooves. The fork and blade rod design permits close spacing of the cylinders. The blade rod is nitrided and chromium plated on the surface which rides on the crankpin bearing.



Unit fuel injector assembly. The design was apparently influenced by the General Motors design.



Forward gear train. Close examination will show the long addendum gear tooth profile which is said to assure contact of two teeth at all times which reduces unit loading. At top is the blower drive flexible coupling assembly and top right is the torsional vibration isolator (identity illegible in the picture).

There are no operational data available on the long addendum spur gear tooth design, but it is reported to provide bearing load on two teeth at all times, thus reducing unit pressure loading and should, therefore, reduce pitting and provide quieter operation.

The construction of the exhaust manifolds so that no more than two cylinders discharge into one passage will prevent interference of the flow of exhaust from any cylinder with the gas from other cylinders.

The use of four small scavenging blowers, in place of the one large unit that is customary on American engines, contributes to the compactness of the engine design. Since all blowers discharge into a common air box, all cylinders receive air from all blowers and there should be no pressure fluctuation. Blower intake noise should be less. Driving two smaller blowers from each gear train materially reduces the loading on each gear train and permits the use of lighter gears. The flexible drive coupling and the torsional vibration isolator protect the blower assemblies from shock loading and from destructive torsional vibration.

Possible Design Improvement

The excellent ratio of horsepower to weight (6.15 lbs. per bhp.) could be still further improved by making certain modifications in several parts. These parts could be reduced in weight and still have the strength and capacity necessary for the engine design.

The cast iron engine crankcase serves no purpose other than as an oil pan. A fabricated, light metal sheet steel oil pan would serve the same purpose and

(*Continued on page 78*)

Diesels at Porto Alegre

A year ago six new diesel generating sets were put into operation in the municipal power plant at Porto Alegre, Brazil. In that time, the diesels, which were installed as a supplement to the existing steam power facilities, have turned in a good operating record.

PORTO ALEGRE, the capital of the State of Rio Grande do Sul, Brazil, is a fast growing industrial city. Like many other cities in Brazil, it was seriously affected during the war years when no generating equipment could be imported in order to meet its growing power demands.

By 1943 the power shortage in Porto Alegre had become so serious, that the State authorities decided to install an emergency power plant in order to supplement the existing power supply during peak loads.

The Comissao Estadual de Energia Electrica, a state government agency, requested bids for diesel power generating units from various manufacturers, and in August 1943 a contract was signed between the CEEE and General Motors do Brasil, S. A. for the latter to furnish and install six diesel generator sets, each rated at 1000 kw., or a total of 6000 kw.

Diesel power was selected principally because it could be quickly and easily installed and thus fulfill the urgent need for economical power. The six units arrived at Porto Alegre in January 1949 and were placed on the line April 12, 1949.

Each of the six units consists of a complete assembly depending only upon its individual forced draft evaporative cooler for water temperature control. The engine is directly coupled to its generator, both mounted on a common steel base at the factory. The engines are rated at 1440 continuous hp. at 750 rpm., at altitudes up to 2000 ft. above sea level.

Engines

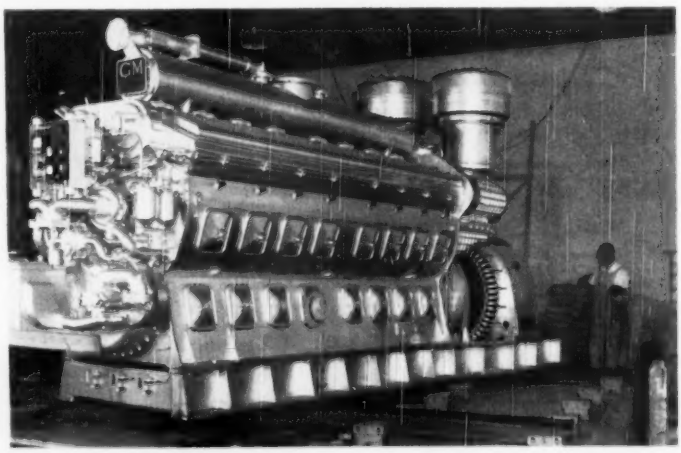
The General Motors engines used for the supplementary power supply are model 16-567-B. The engines are 16-cyl., two stroke, V-type engines with a bore and stroke of 8½ by 10 inches. A piston speed of 1250 fpm. at 750 rpm. is attained and the compression ratio is 16 to 1.

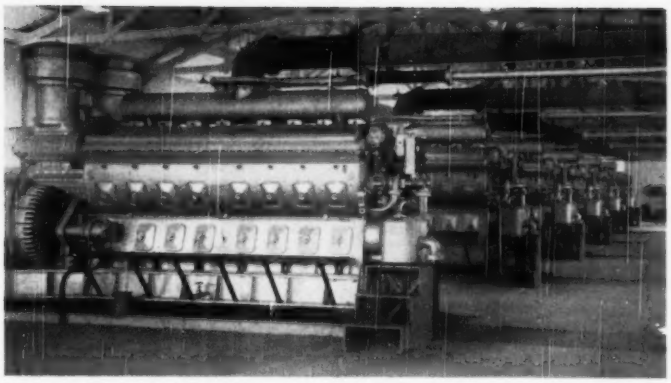
The camshaft is in two sections, specially fitted together and balanced. The journals are Tocco hardened and the shaft is supported by ten main bearings. Harmonics are dampened by the use of a harmonic balancer bolted to the front end of the shaft. Main and connecting rod bearings are of the precision type. No shims, adjustments or fittings are required for installation. Scavenging air is supplied by two Roots type blowers with helical lobes driven from the camshaft gear train. The air intake is supplied with an oil bath type air intake cleaner.

Exhaust valves and injectors are actuated by rocker arms directly from the overhead camshaft. Each camshaft is made up of eleven sections and bolted together. All journal surfaces are hardened. Once the camshaft is installed, no further adjustments are necessary.

The engine fuel oil system consists of a low pressure circulating oil pump, and the General Motors unit type injector. The pump constantly circulates fuel oil through the injectors, keeping them air free, and at the same time cooling them. The unit injector is a combination of high pressure fuel pump and metering pump, thus eliminating high pressure fuel lines and injection time lag. Each injector is operated by a rocker arm. Injection pressures reach 17,000 psi. at full

One of the 48,000-lb. (dry) units being skidded into place on the vibration dampeners.





The six engines completely installed and at work. Uniformity of installation and generous engine spacing facilitates maintenance work.

load, thus insuring perfect atomization and complete burning of the fuel.

Cylinder liners are cast integrally with the water jacket. The piston and wrist pin are full floating, thus permitting the piston to rotate as well as reciprocate while in operation. There are three compression rings and two oil control rings per piston.

Connecting rods are of the interlocking blade and fork rod construction. The blade rod oscillates on the back of the upper bearing shell and is held in place by a counter bore in the fork rod. Connecting rod bearings consist of upper and lower shells.

Each cylinder head has four exhaust valves, operated by two rocker arms and two valve bridges. These bridges are fitted with hydraulic valve lash adjusters. During operation there is no clearance between the valve stem and lash adjuster tappet. The four overhead valves and the excess air supplied by the blower entering the cylinder through the uncovering of the cylinder liner air intake ports by the piston insure excellent scavenging, cooling and high volumetric efficiency.

Electrical System

The units are directly coupled to an Elliott Co. generator. Two pedestal bearings support the rotor and are lubricated by oil slinger rings. The exciter, supplied by the same manufacturer, is mounted on top of the main generator and is driven by the engine gear train, through a flexible coupling. The generator is rated at 1250 kva., 6600 volts, 50 cycle, 0.8 power factor.

The generator control switchgear is a totally enclosed metal clad model manufactured by General Electric. There are two panels per unit, a generator and an exciter panel.

A distribution and station service panel are mounted in the center of the generator control panels. Each generator panel and the distribution panel have a main air circuit breaker. Voltage is controlled by General Electric diactor voltage regulators, and each generator is protected against overloads, grounds, and reverse currents by relays closing the breaker trip circuits.

Two banks of storage batteries supply current at 120 volts for engine starting, switch gear and board operation, and engine alarm systems. The batteries are kept in full charge by an automatic Fansteel battery charger. Each engine is equipped with a 120 volt electric starter.

Accessories

Two fuel oil centrifuges and transfer pumps centrifuge all fuel oil before the latter is transferred to the six individual day tanks from the main storage tanks. A portable lube oil service pump is used to change the lubricant which is centrifuged prior to reuse.

Power Plant and Installation of Units

Immediately after the contract for the six diesel engine generator sets was signed between the CEEE and General Motors do Brasil, construction of the power plant was started near the center of the city. This power plant consists of an area of 900 square meters, brick walls and wooden trusses covered with asbestos roofing material.

The building was designed to permit an adequate clearance between units, which is 3.50 meters obtained by placing the units 500 meters between engine axis. Space was left for a seventh unit.

The building was partially completed when the six units arrived in Porto Alegre. Each foundation for the units consists of 17 cubic meters of reinforced concrete on six concrete piles. Steel plates on each foundation were leveled, grouted, and bolted to the foundation to serve as a common base for the fourteen engine supporting vibration dampers. Each unit weighs 48,000 lbs.

As the bases for the units were ready when the latter arrived, one unit per day was mounted on its respective base. All water, fuel oil, lubricating oil and exhaust piping was completed in 20 working days for all six engines while workmen completed the building.

Each unit is equipped with two exhaust mufflers, one mounted horizontally along the exhaust pipe inside the building and the second muffler mounted vertically outside the building in order to eliminate virtually all noise.

Each unit is furnished with fuel from its individual day tank which has a capacity of 502 gals. mounted inside the building. These day tanks are replenished from three above-ground storage tanks with a total capacity of 15,852 gals. The fuel is centrifuged and filtered before entering the day tank. This system has proved very satisfactory, as after 1500 hours of operation the engine mounted micronic fuel filters have not been replaced, show no signs of dirt or any drop in fuel oil pressure. The injectors have operated without fault.

The lubricating oil system of each engine is protected by its Cuno strainer and purified by Hilco by-pass filters. The engine circulating water passes through the oil cooler before entering the engine water jackets.

Carrier evaporative type coolers are used for engine jacket cooling. Engine

jacket water circulates through coils and the lubricating oil cooler. Engine jacket water temperatures are controlled automatically by a thermostatically controlled air draft louvre motor. These louvres control the air circulation through the evaporator. Lubricating oil temperatures are controlled by a thermostatically operated three way-valve. Jacket water and engine oil temperatures are maintained at 175 and 185 deg. F. respectively. Four inch piping was used for the engine jacket water and lubricating oil from the engine to the evaporator and oil cooler both placed outside the building. This piping is laid inside channels recessed in the engine room floor.

All units are protected by an audible alarm system against low lubricating and piston cooling oil pressures, and high water temperatures.

List of Principal Equipment

Engines:	Six, General Motors, Model 16-567-B, 1440 hp., V-type, two-stroke, 16-cyl., 8½ by 10 in. bore and stroke.
Generators:	Six, Elliott Company. Coupled directly to engines, rated at 1250 kva., 6600 volts, 50 cycle, 0.8 power factor.
Control Panels:	Six, General Electric Co., one set per engine. Set includes a generator and an exciter panel.
Distribution Panel:	One, General Electric Co.
Service Station Panel:	One, General Electric Co.
Battery Chargers:	Two, Fansteel Metallurgical Corp. Selenium battery charger. Panels.
Storage Batteries:	Two sets. Prestolite, Brazil.
Oil Centrifuges:	Two, Fuel oil, one Lube oil, De Laval.
Fuel Transfer Pumps:	Two, General Electric Co.
Lube Oil Strainers.	Twelve, Purolator Products, Inc. Six, Cuno Engineering Corp.
Lube Oil Filters:	Six, Hilliard Corporation (Hilco)
Fuel Oil Filters:	Six, Hilliard Corporation (Hilco)
Silencers:	Twelve, Maxim Silencer Co.

Operating Results

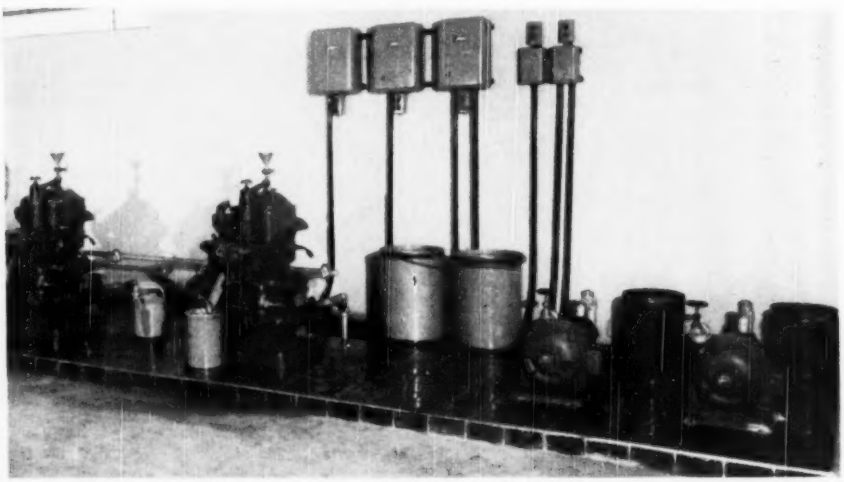
The six units were placed on commercial load operation on April 12, 1949. The units were put through the customary acceptance tests and met all contract requirements. Fuel oil consumption on each unit was an average of 0.074 gal. of fuel and 0.0000034 gal. of lubricating oil per kwh. on the board at full load.

The units can generate at 10 per cent overload for one hour, and the plant can be placed on full load operation in a matter of a few minutes. The units are at the disposal of the main load dispatcher and at his request any load up to 6,000 continuous kw. can be quickly handled to suit requirements.

These units operate in parallel with the city's steam turbine plant. No paralleling or operating difficulties were encountered, as the governors of each engine are adjusted to maintain a desired load output with very little variation.

Operating and maintenance personnel were trained on the job during plant erection by General Motors engineers. Important assemblies of the engine were disassembled for the benefit of the maintenance crew. This training has proven to be very effective, as the units have had 100 per cent availability at this writing. M. Yacon, Erection Supervisor, Z. A. Sereda, General Motors Service Engineer and C. R. Bell, Diesel Manager, General Motors do Brazil S. A. were the men responsible for the installation.

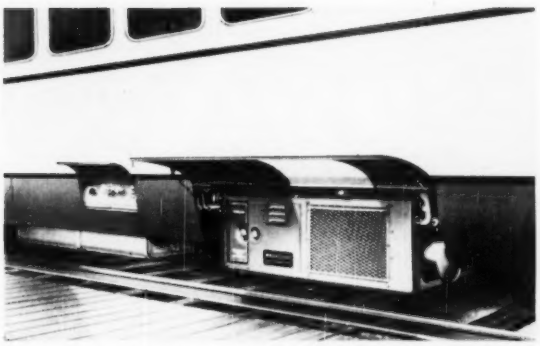
Interesting features of this installation demonstrate that diesel electric power can be installed at a low cost per kilowatt, rapidity in installation and placing in service, low cost of operation and maintenance and great flexibility.



Fuel handling facilities include centrifuges for cleaning and the transfer pumps.

WAUKESHA *Diesels*

NOW IN RAILWAY SERVICE



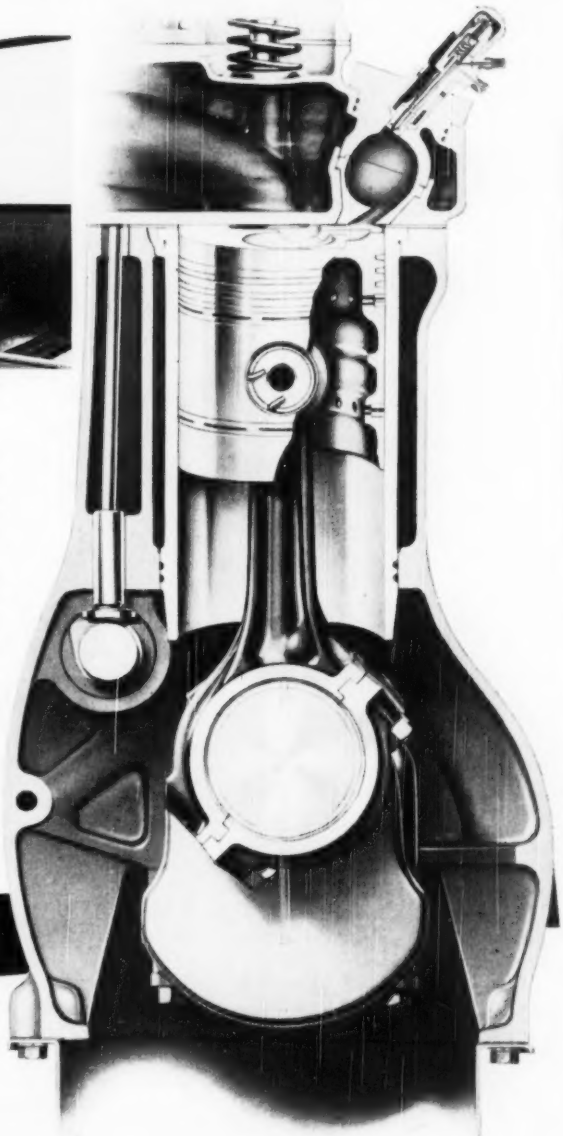
Waukesha Diesel Enginator (engine-generator) with adjacent 200-gal. Diesel fuel tank. Car skirts raised to show roll-out mounting.

● Railway passenger cars are now being equipped with Waukesha Diesel Enginators (engine-driven generators) of 25 KW capacity, DC, or AC systems, which supply all electric services—emergency heating, air conditioning, lighting and even cooking and food preservation.

This Waukesha Railway Diesel is a specialized application of the Waukesha Standard Industrial Diesel Engine, Model 190-DLC. A six-cylinder, four-cycle, solid injection, compression ignition full Diesel . . . built with rugged simplicity. Its bore is 3¾ in., stroke, 4 in., with 265 cu. in. displacement. Burns all modern high speed Diesel fuels of 45 cetane or above . . . cleanly, smoothly, without shudder. Acceleration is lively, fuel economy high; starting is easy, up-keep low.

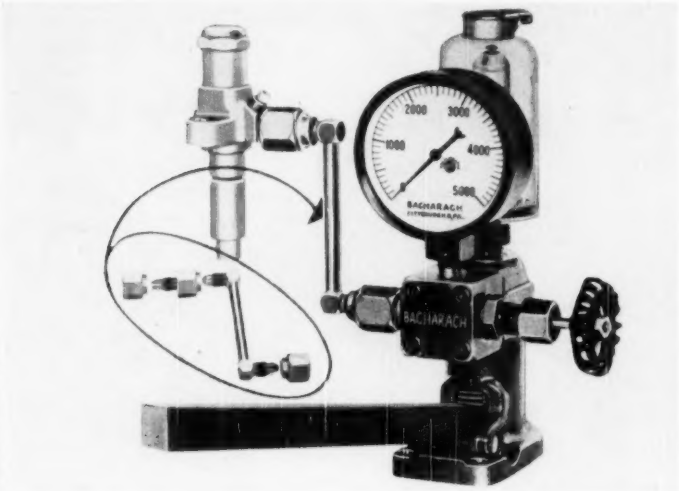
The most outstanding of its many special Diesel design characteristics is the exclusive combustion chamber. Spherical in shape, with two swirl cups in the piston crown—turbulence is controlled constantly and automatically. Burning rate increases or slows, with engine speed. No complicated advance and retard mechanism in injection pump needed. *Get Bulletins 1411 or 1412.*

WAUKESHA MOTOR COMPANY
WAUKESHA, WISCONSIN
NEW YORK • TULSA • LOS ANGELES



Section through one element of Waukesha Railway Diesel Engine showing exclusive Diesel combustion chamber with pintle type injection nozzle and swirl cups in piston crown. Other details include wet sleeve cylinder, five-ring piston, angle cut connecting rod cap with integral key and keyway construction. Rod is drilled for pressure lubrication of full-floating piston pin.

New Products



Redesigned Nozzle Tester

The Bacharach Nozzle Tester has been redesigned to provide a unique method of connecting the nozzles to the tester by means of a connector tube and interchangeable nuts. This is said to result in a "universal" tester suitable for rapid and effective watching of all injection nozzles such as American Bosch, Bendix, Demco and many others.

The illustration shows how one connector tube serves as support for the nozzles of 235 different makes and types of diesel engines. Connection of the various sizes and types of nozzles to the connector tube is accomplished by the interchangeable nuts which have two-way threads. One end of the nuts has right-hand threads matching the fuel inlet threads of the nozzle to be tested, and the other end has left-hand threads matching the threads on the connector tube. Attachment of the nozzle merely requires starting right and left-hand threads at the same time and turning the nut clockwise until the connection is tight.

Moisture Absorber

Successful application of S V *Sovabead*, a new moisture-absorbing chemical, in the commercial drying of natural gas before it is transported through pipelines has been announced by the Socony-Vacuum Oil Co., Inc.

Sovabead, technically, is a chemically inert solid siliceous material in the form of beads. Extensive field tests over the past three years have shown it to be extremely effective for drying natural gas. Specifically the firm says the tests have proved:

1—Sovabead doubles the absorption capacity of the drying towers.

2—The overall operating efficiency of natural gas drying units is enhanced through elimination of "caking" and reduction of pressure drops, "channelling" and "dusting"—all of which are difficulties experienced with other solid desiccants (drying agents).

3—The chemical resists fouling by so-called "sour" gas, with the result that desiccant costs are materially reduced by increased service life.

4—It maintains high absorption capacities while maintaining the necessary low dewpoints even when the temperature of inlet gasses goes as high as 120 deg. F.

5—Use of *Sovabead* brings lower ultimate drying costs.

New Engine Model

A new single-cylinder, water-cooled, diesel engine has been added to the line of Sheppard diesels. Tests, which the company has been conducting for the past year, are now completed and the new diesel engine is ready for distribution.

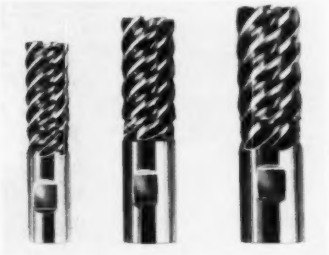
The new engine which has been designated as Model 9, is a 4-cycle, 1-cycl. full diesel engine with a gross rating of 8.4 hp. and a continuous rating of 5.6 hp. The model 9 diesel is available as a power unit or a 3 kw. generating set with radiator, heat exchanger, or tank cooling. Model 9 is extremely compact in design and it is anticipated that it will meet with acceptance for use in locations where weight must be kept down and space is at a premium.

Flexible Hose Application

In an unusual application of flexible metal hose, Chicago Metal Hose Corporation Rex-Weld Corrugated Hose, Type RW-90, has been incorporated into the design of Waukesha Diesel "Enginators" as heat exchangers for generator cooling air. The "Enginator", which consists of a unitized diesel engine-generator set, is designed to be mounted under railway cars to provide a constant source of electricity whether the train is standing or in motion. The CMH Rex-Weld Corrugated Flexible Metal Hose is mounted on the side of the generator and cooling air circulated through it. The air within the flexible metal hose is completely enclosed and is never mixed with outside air, thus giving protection against moisture, road dust and the elements. The corrugated hose offers substantial cooling surface, yet requires a fraction of the space a conventional heat exchanger would require.

End Mill

The Shearcut Tool Company has developed a new *Shearcutting* type of end mill which applies the rotary broaching technique to milling machine operation.

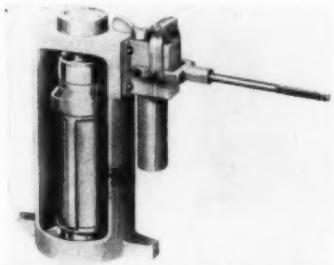


The helical cutting edge is said to have an extremely large angle compared to the axis of rotation, causing a true *Shearcutting* action on the metal being removed. Flats have been provided on the straight shank type so that set screws may be used to lock the tool in position, to resist the end thrust which is developed by the shearcutting action of the tool.

Shearcutter end mills are ground from the solid after having been hardened to a Rockwell "C" reading of 63 to 65, assuring a keenness to the cutting edges which can be achieved in no other way.

Sleeve Remover

A hydraulic sleeve remover which, the manufacturer says, will remove worn sleeves as well as install them, is now being produced by the Marvel Tool and Machine Co. A pull of 20,000 lbs. can be exerted by a force of 50 lbs. on the handle of the machine.

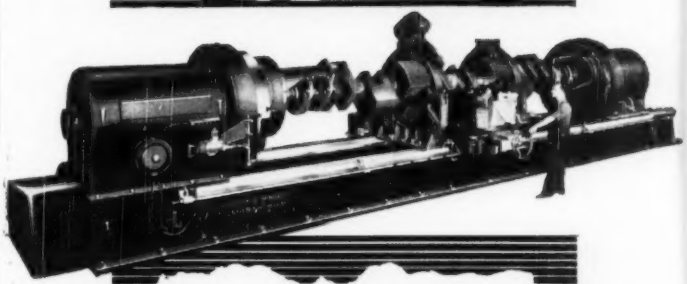


In use, the machine is placed over the bore of the disassembled engine and a control valve is turned to the "in" position. The machine cylinder is pumped up and down until the fingers catch the bottom of the sleeve and then the valve is turned to the "out" position. Pumping the handle then pulls the sleeve out. The machine will take up to a 5 in. bore in $11\frac{1}{4}$ in. stroke.

Redesigned Coupling

The Falk Airflex Coupling has recently been redesigned after ten years of successful service in the most difficult coupling applications. Improvement in rubber composition and bonding are said to have increased the torque capacity 20 per cent above previously published values while the hubs and adaptor plates have been redesigned to facilitate disconnection and removal of the entire gland assembly. Redesigned components are entirely interchangeable with the equivalent components of all Airflex Couplings now in use and standard parts may be combined to allow six different mounting arrangements including

SAVE UP TO 400%
MACHINING TIME WITH
WICKES
UNIVERSAL CRANKSHAFT
LATHES



Higher production and greater flexibility accompany the Wickes Universal Crankshaft Lathe, designed to machine crankpins and line bearings on all sizes and types of crankshafts. Savings in time up to 400% have been made by machining in this lathe as compared to the time of machining in an engine lathe. Wickes Universal Crankshaft Lathes are equipped with single or double end drive, indexing and stroke setting pot chucks, 3-station turret and a back roller rest. If you have a crankshaft turning problem, call on us for time studies and proposals on the most suitable equipment.

WICKES BROTHERS
SAGINAW, MICHIGAN
Established in 1854
DIVISION OF THE WICKES CORPORATION

Complete Line of Crankshaft Turning Equipment • Thread Milling Machines • Heavy Duty Engine Lathes • Special Production Lathes • Sheet Reclaiming Rolls

KIENE MODEL K-120 UNIVERSAL PEAK PRESSURE INDICATOR

Model K-120 with cooler body and nozzle dummy.

MODEL K-120 Indicator has but one moving part—nothing to wear or get out of adjustment.

VALVE—Gas trap type with diaphragm type check valve having adjustable lift. Stainless steel valve and seat.

No springs—No pistons—no complicated adjustments—No temperature corrections—no pressure loss in check valve.

GAGE READS TRUE PRESSURE—MAY BE RECALIBRATED ON ANY GAGE TESTER

Check readings can be made over and over again by releasing indicated pressures with bleeder valve.

GAGE—Hydraulic 3½ inch dead weight tested in suitable range to specification requirements.

ADAPTORS available for most models of engines manufactured in U.S.A. Other models made to order at reasonable prices.

For

Testing Firing and Compression Pressures on all Models of Diesel and Gas Engines

Dependable — Easy to Use — Rugged. May be Used With or Without Flexible Tube.

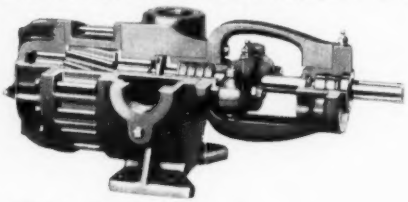
DESCRIPTIVE BULLETINS AND PRICES FURNISHED ON REQUEST

Manufactured under patents No. 2280411, No. 2325325, others pending

KIENE DIESEL ACCESSORIES, INC.
10352 PACIFIC AVE., FRANKLIN PARK, ILLINOIS

ROPER ROTARY PUMPS

The Name of Dependability



Widely Used in Diversified Industries

Whether your equipment is dependent upon a pump for fuel transfer, coolant work, or hydraulic action, you will maintain greater operating efficiency with the rugged Roper — Series F. This series is built to pump clean liquids of all kinds, and is available in standard or special-built designs in 1 to 300 g.p.m. . . . pressures to 300 p.s.i. WRITE TODAY for Catalog and Complete Information.

GEO. D. ROPER CORP.
165 Blackhawk Park Ave.
Rockford • Illinois

ROPER Rotary Pumps

flange mounting on a flywheel. Stiffness factors can be controlled and are available for torsional analysis.

Water Testing

A new low cost, rapid and accurate method of testing diesel cooling water on the spot has been announced by Dearborn Chemical Company. Called the *Dearborn Chromokit*, the small, portable kit permits convenient field testing of diesel units by means of a spot test using chemically impregnated test cards. The color reaction which results from applying only one drop of the cooling water sample indicates treatment strength and permits accurate adjustment within a matter of minutes.

The *Chromokit* is a sturdy metal case containing four sample bottles, a packet of test cards to conduct 30 tests, color standard guide, and treatment adjustment chart. A sample of cooling water containing treatment is taken in the dropper bottle. One drop is placed on the test card. After two minutes the color reaction is matched against the standard color guide, indicating chromate strength present.

Five color spots on the guide indicate variations from satisfactory range to inadequate strength. When chromate strength is low, the spot value is checked against the Treatment Adjustment Chart which indicates additional treatment required by cooling systems of various water capacities ranging from 50 to 300 gallons.

Industrial Roll-Cab

Production of a large size *Roll-Cab* designed especially for industrial use has been announced by Snap-on-Tools Corp. This *Roll-Cab* is said to provide the user with a "shop-on-wheels" that can be rolled right to the job: and, as all necessary tools, equipment, and material are carried in the cab, it eliminates the time wasted on repeat trips to the tool crib.

The top measures 45 x 24 inches to provide plenty of working space for the mechanic or maintenance man. To provide a rigid work surface capable of mounting a vise or bench grinder, a reinforced solid steel top plate approximately 3 16 in. thick is

used with a cemented masonite covering.

The Roll-Cab is constructed of heavy gauge steel and is spot welded throughout for strength and rigidity as well as to provide a smooth surface with no edges or projections to catch and tear clothing. Seven drawers of various sizes provide storage space, and all are equipped with ball-bearing "slide-runs" which provide easy operation even when fully loaded and prevent drawers from sagging or pulling out. Additional storage space for larger items is furnished by two compartments, and the back of the cab contains a series of 20 small bins for nuts, bolts, washers, etc. All drawers and compartments can be locked when the Roll-Cab is not in use to prevent loss of valuable equipment from theft.

Long Scale Instruments

A large $28\frac{1}{4}$-in. scale instrument with a spot-of-light pointer has been placed on the market by the Cole Instrument Co. The firm says the instrument, applicable to such purposes as speed and power indications, dynamometer readings, production testing, monitoring motor loads, reading generator output, and other applications, will be especially useful to those who must attend to numerous operations at various points remote from the instrument.

The light beam pointer is produced by light passing from a self-contained light source through a precision optical system reflected on a first-surface mirror directly on the instrument scale. The optical pointer can be provided with a hairline where extreme accuracy is desired.

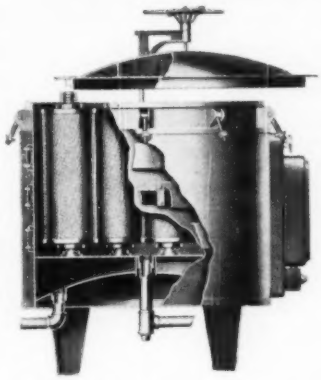
Lapping Tool

Ideal Industries, Inc. announce a new self-aligning, self-adjusting lap. It is different in that its unique design principle provides a constant self-expanding pressure between lap sleeves and work.

The Ideal "*Xpand-O-Lap*" requires no manual adjustment. It consists of one steel arbor, two serrated copper sleeves and one S-shaped pressure spring. The spring applies constant, even pressure against the two sleeves.

Less time for a change!

HOFFMAN Cartridge Filters



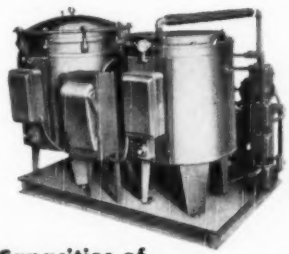
Simplify Cartridge Replacement with Exclusive Cover-Lifting Device

Along with efficient filtering at high flow rates, Hoffman Cartridge Filters provide maximum service convenience. Exclusive cover-lifting device speeds up cartridge change – either the 7 x 18 size, for Navy throw-away cartridges, or the 11 x 18, for repackable or throw-away types, offer this feature. Swing bolts fasten the cover – an additional advantage for cartridge changes.

FOR LUBRICATING, FUEL OR INDUSTRIAL OILS

Two sizes: I-718 for 7 x 18 Navy-size throw-away cartridges in multiples of 1, 2, 4, 7, 9, 14, and 18 cartridges. I-1118 series, for either repackable or throw-away cartridges, in multiples of 1, 2, 3, 4, 6, and 8 cartridges.

Write for bulletins A-703 and A-649 respectively.



Complete Recovery of Used Oil

–The HOFFMAN OIL CONDITIONER

Removes insolubles, as well as solubles, to cut new oil costs. Unit consists of Hoffman Vaporizer (to remove oil, gas, moisture and fuel dilution) . . . Cartridge Filter to remove solubles. Mounted on a common base . . . only 2 moving parts . . . no steam or water connections.

Capacities of 50 to 600 g.p.h.

Write for Bulletin A-667 and A-668

FILTRATION DIVISION

U.S. HOFFMAN MACHINERY CORPORATION

214 LAMSON STREET, SYRACUSE 6, N. Y.

CANADIAN PLANT: CANADIAN HOFFMAN MACHINERY CO., LTD., NEWMARKET, ONT.

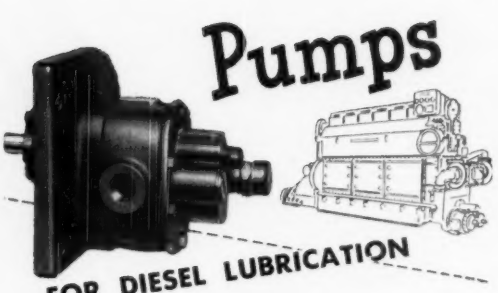
Promotes Rapid and Effective Servicing of *All* Makes of Diesel Nozzles and Injectors

All Diesel injection nozzles, due to the nature of their operation and the severe conditions to which they are subjected in service, require maintenance at regular intervals. That's why the need of nozzle cleaning and testing is emphasized in every Diesel builder's instructions.

The Bacharach Nozzle Tester provides a dependable means for checking nozzles accurately. Its low price — $79.00 — makes it a worthwhile investment for every Diesel operator and service shop. A complete line of connector fittings is available for American Bosch, Excello, Demco and Bendix nozzles; as well as GM 71 and Cummins unit injectors.

Ask your engine parts jobber to show you the Bacharach Nozzle Tester and our other Diesel testing instruments, or write for Bulletin 617.

BACHARACH Industrial Instrument Company
7000 Bennett Street · Pittsburgh 8, Pa.



THE rotary geared pump shown above is particularly suited for diesel lubrication systems. It has a special flange mounting to facilitate installation together with provision for tachometer drive.

Thousands of Brown & Sharpe Pumps are now providing trouble-free service for transfer, lubrication and booster systems. Get acquainted with their reliability and economy. Write for Catalog. Brown & Sharpe Mfg. Co., Providence 1, R. I., U. S. A.

We urge buying through the Distributor

BROWN & SHARPE BS

Diagonal grooves in the sleeves serve as channels for the lapping compound.

"*Xpand-O-Lap*" arbors last longer because they have no set screw to wear or possibly "freeze" and break off under heavy-duty and frequent adjustments. The only servicing it ever needs is the occasional replacement of low-cost sleeves or pressure spring. This takes just a few seconds. Pressure springs are of specially tempered steel to maintain unvarying pressure for long periods.

Ratchet Drive

A new 3/8 in. drive "junior" *Ratch-A-Daptor* is being introduced by the Herbrand Division of the Bingham-Herbrand Corp., as a companion model to its 1/2 in. drive *Ratch-A-Daptor*. The new model J-8 fits all 3/8 in. drive handles and sockets and features a simple ring shift for converting to right or left drive. It makes a ratchet extension when attached to any 3/8 in. drive T-handle, flex handle or extension handle. Sealed to keep out dirt and grit, the J-8 has 20 teeth for secure grip at any position.

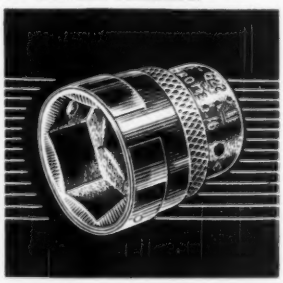
Vibration Isolator

A new vibration isolator is now available for mounting pumps, compressors, fans, engine-generator sets, and other equipment where efficient, economical and rugged isolation is required. This isolator was designed primarily for original equipment manufacturers and is intended for either marine, mobile or stationary installations. Its heavy duty construction is said to make this isolator especially suitable for equipment where service conditions are severe, as in marine or mobile applications. It is manufactured by The Korfund Co.

Socket

A socket that eliminates the exasperation of dropping and losing nuts, plugs and bolts in removing or in starting them is announced by the Herbrand Division, Bingham-Herbrand Corp. The new *Hold-It Socket*, is designed with two spring-tension pins in the socket wall to firmly grasp and hold nut or plug.

At present the *Hold-It Socket* is available in 3/4 in. and 11/16 in. 6-point sizes, with production on a wider selection scheduled.



Sleeve Castings

Cylinder sleeve castings that, when machined and installed in an engine, are said to considerably outwear sleeves cast by conventional centrifugal methods, and that cost less than statically-cast sleeves, are now in volume production by Perfect Circle Corporation.

Perfect Circle is making only the rough castings that are machined by sleeve and engine manufacturers into cylinder sleeves. No machining is done on the castings by Perfect Circle.

Perfect Circle's sleeve castings are gray as cast—they require no annealing. Out of-roundness of the castings is held to a maximum of 0.010 in. The castings are said to be free of dirt, are not porous, and not subject to shrinkage.

Outer and inner diameter dimensions, because of the process, are held to plus or minus one thirty-second of an inch. Length of the castings is held to plus or minus one sixty-fourth of an inch.

Generator Sets

Production of a standard commercial line of Cummins diesel-powered electric generator units is announced by Cummins Engine Company, Inc.

Sixty-cycle units are available in 40, 50, 60, 75, 100, 125, 200 and 250 kw. ratings. Similar units are also available for 50-cycle operation at a slight de-rating in kw. capacity.

These diesel generator units are designed for continuous service applications where the unit is the primary source of power. Their instant starting and high availability characteristics also are said to make them excellent standby or emergency sources of power.

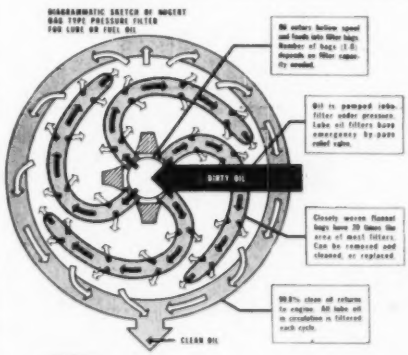
Optional equipment offered by Cummins for the various generator units includes automatic overspeed shutdown control; automatic high temperature and low lubricating oil pressure shut-down; complete marine-type or radiator-type cooling systems; hydraulic governor; water-cooled exhaust manifold, and generator mounted package control unit. Special generator voltages and kw. ratings are also available.

19 Years of Protection for 7 Diesel Locomotives

with NUGENT "Full Flow Filtering" Pressure Filters

In 1930 Bush Terminal Warehouse, Brooklyn, N. Y., put into service seven Ingersoll-Rand diesel powered G. E. locomotives. All were equipped with Nugent *"Full Flow Filtering"* Bag-Type Filters for lube oil. Now after 19 years all seven locomotives are still in service and only one has had to be overhauled (that after 18 years service). The Nugent Filters are cleaned every three or four months and the bags washed and re-used. Here is proof of the long term economy and effectiveness of Nugent Full Flow Filtering.

Nugent *"Full Flow Filtering"* Filters are equally effective on compressors, pumps, turbines, gas engines, machinery etc. and may be used on a wide variety of oils and other fluids. What is your problem?



What is "Full Flow Filtering?"

"Full flow filtering is complete filtering of *all* the oil every cycle. No unfiltered oil bypasses the filter carrying harmful foreign material to moving parts. In Nugent *"Full Flow Filtering"* Filters, dirt is collected on the inside of the filter bags which when clogged can be cleaned and reused or discarded and replaced at your preference. For Maximum economy and longest equipment life be sure and specify Nugent *"Full Flow Filtering"* Filters.

Wm. W. Nugent & Co., Inc.
417 N. Hermitage Ave. CHICAGO 22, ILLINOIS

Established 1897

OIL FILTERS, OILING AND FILTERING SYSTEMS, TELESCOPIC OILERS, OILING DEVICES, SIGHT FEED VALVES, FLOW INDICATORS

Representatives in Boston • Cincinnati • Detroit • Houston • La Junta, Colo. • Los Angeles • Minneapolis • New Orleans • New York • Philadelphia • Portland, Ore. • San Francisco • Seattle • St. Louis • Tulsa • Representatives in Canada: Montreal • Toronto • Vancouver

Field Notes

Cummins Racer

Only diesel-powered entry in the Indianapolis Speedway 500-mile classic, May 30, the Cummins Diesel Special is shown above, for the first time, alongside a top gasoline-powered contender, Kurtis-Kraft's No. 1 Championship race car of 1949. The low-slung, completely streamlined racer is only 40 inches high at its highest point. It is powered by a highly supercharged, revised version of the lightweight, high-speed Cummins JS-600 engine. Body and chassis were built by Kurtis-Kraft of Los Angeles.

With the two cars are, left to right, Jimmy Jackson, popular driver of the Cummins Diesel Special; D. J. "Don" Cummins, vice-president in charge of engineering for the Cummins Company; Frank Kurtis, builder of both cars, and Johnny Parsons in the car that placed second at Indianapolis in 1949.

Rock Island Dieselization

Further steps toward eventual complete dieselization of the Rock Island Lines, have been announced by the railroad's Board of Directors, meeting in Chicago. The Board authorized the purchase of twenty (20) new diesel locomotives to cost approximately $2,500,000.

In making the announcement, J. D. Farrington, president of the Rock Island, said the new locomotives would be assigned as follows: twelve (12) 1500 horsepower units for road and switching operations; one (1) 2250 horsepower engine for passenger service and seven (7) 800 horsepower units to be used in switching.

The additional 20 diesel locomotives, when delivered, will make the railroad one of the largest users of diesel power in the country.

Crude Oil Finds

Major discoveries during 1949 in West Texas and Southeast New Mexico enabled the Socony-Vacuum Oil Company, Inc., to attain an outstanding year in finding crude oil in the United States. Only one other year in the company's history remotely compares with 1949 in volume of oil found.

The company's domestic reserves of crude oil and condensates at the year's end are estimated at one billion 330 million barrels compared with one billion 194 million at the end of 1948.

A major discovery was the Pegasus field in Upton County while several thousand acres of productive leases in Scurry County also appear promising. In the Bough field, Lea County, New Mexico, the company brought in three flowing wells of large potential at 9600 feet.

Salesmen Awards

Ten retail salesmen have been honored for their outstanding achievements in the sale of diesel engines in 1949, according to an announcement by Mr. V. C. Genn, General Sales Manager of Detroit Diesel Engine Division. They have been awarded diamond rings and certificates of merit under a plan sponsored by W. T. (Bill) Crowe, General Manager of the company.

Following are the names of men who received the 1949 W. T. Crowe Diamond Award:

Charles R. McDonald
Walter H. Moreton Corp.
Cambridge, Massachusetts

Andrew W. Winnberg
Frantz Equipment Company
Philadelphia, Pennsylvania

J. A. Dunham
Diesel Equipment Company, Inc.
Wichita, Kansas

N. N. Elkins
Stewart & Stevenson Services, Inc.
Corpus Christi, Texas (Branch)

Lee Hardiman
Florida Diesel Engine Sales
Jacksonville, Florida

Samuel P. Vinson
Lewis Diesel Engine Company
Memphis, Tennessee

David H. Geary
Western Machinery & Engine Company
St. Louis, Missouri

S. T. Collins, Jr.
Olson Manufacturing Company
Boise, Idaho

Gilmore R. Salyers
Anderson-O'Brien Company
Los Angeles, California

Bradley Bartlett
Evans Engine & Equipment Company
Seattle, Washington

Cooper-Bessemer Pact

A contract recently concluded between The Cooper-Bessemer Corporation and Harland and Wolff, Ltd., world-noted British shipbuilder and engine manufacturer, now licenses Harland and Wolff to build Cooper-Bessemer "V" angle-type compressors abroad. The compressors covered by the contract are the Cooper-Bessemer type JM motor-driven units, and the GMX, GMV and GMW "V" angle-type gas engine-driven units, according to Gordon Lefebvre, President of the Cooper-Bessemer Corporation.

"Under the terms of our agreement, Harland and Wolff is to manufacture and sell our compressor line to many of the countries now included in the sterling area", explained Mr. Lefebvre. "The areas include the United Kingdom, British Dominions and Commonwealth (excluding Canada), colonies, possessions, protectorates and mandated territories of Great Britain. Included also is the European continent, Iran, Kuwait, Iraq, Turkey, Syria, Lebanon, India, Pakistan, Burma, all of South America (excluding Venezuela, Columbia, Peru), the French Colonial Empire, Egypt and Israel. Our agreement with Harland and Wolff, however, stipulates that Cooper-Bessemer reserves the right to continue to sell direct to such companies as are now located in the Harland and Wolff area but whose purchases are engineered and contracted for in this country."

The agreement with Harland and Wolff, approved by the British Ministry of Supply, further stipulates that royalty payments to Cooper-Bessemer will be made in dollars.

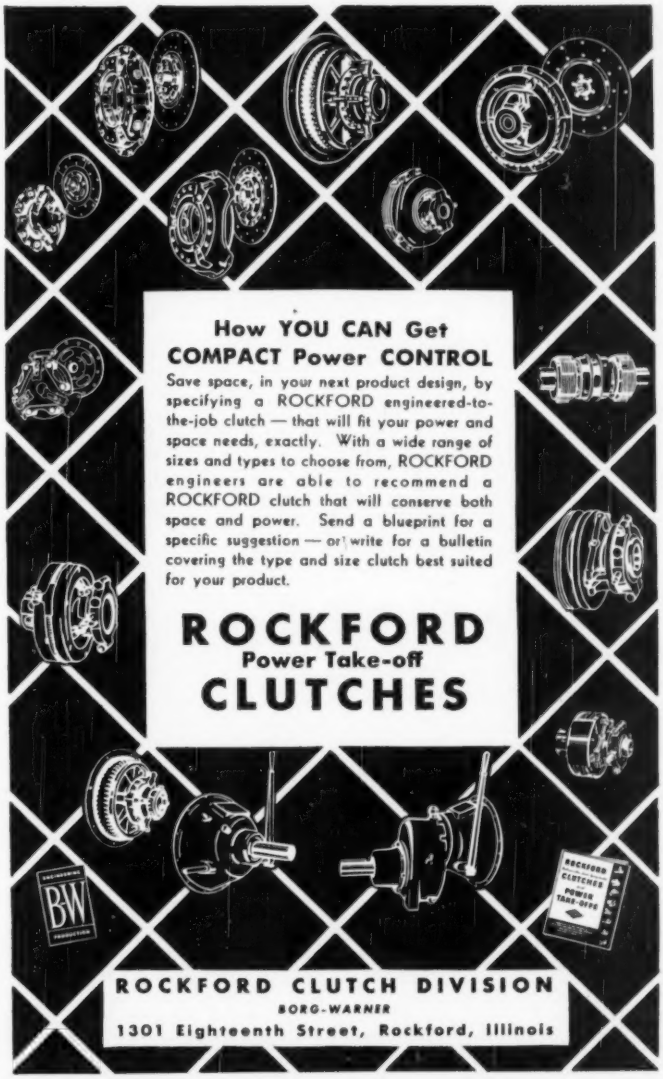
Educators to Attend Bosch Service School

Upon the occasion of the DEMA-Bosch Diesel Symposium held in October, 1949, at Bosch's plant in Springfield, Mass., the corporation announced its willingness to conduct special courses exclusively for educators. The classes were to be held in the completely equipped Service School that is a part of the plant and is maintained for the purpose of instructing personnel sent by Bosch distributors and customers having injection equipment service facilities.

At the time of the announcement it was stated that for practical reasons and in the interest of personal instruction, the classes would be limited to 12 persons. One class was scheduled with possibility of a second should the demand be sufficiently great. Response was so great that not only is the second class full but a third is well under way.

It is a fine commentary on the caliber of our educators that so great a number demonstrated their interest in improving their own backgrounds in order to do a better teaching job, to be fully appreciated, it must be realized that these men are taking their own time and in most cases paying their own expenses. Interest is by no means local as evidenced by enrollments from schools scattered from the South to the Mid-West.

This is another example of the success of the DEMA Educational Pro-


How YOU CAN Get
COMPACT Power CONTROL
Save space, in your next product design, by specifying a ROCKFORD engineered-to-the-job clutch — that will fit your power and space needs, exactly. With a wide range of sizes and types to choose from, ROCKFORD engineers are able to recommend a ROCKFORD clutch that will conserve both space and power. Send a blueprint for a specific suggestion — or write for a bulletin covering the type and size clutch best suited for your product.
ROCKFORD
Power Take-off
CLUTCHES
ROCKFORD CLUTCH DIVISION
BORG-WARNER
1301 Eighteenth Street, Rockford, Illinois

It's New!

Patented Palm-Grip Design. Handles give a secure hand grip and better appearance.

32 tooth ratchet action—pawl always makes a double tooth contact for added strength.

Easily removed Welch plugs permit cleaning and servicing of friction grip device.

Four-way socket grip makes it easier and faster to interchange various units. Hot broached chip-curled openings give you smooth strong socket walls.

Snap-on metallurgists select only high grade alloy steel to produce Snap-on wrenches.

Controlled heat treating combines surface hardness with skin-to-core toughness in every part of every tool.

Snap-on "Supreme"

23-PC. MASTER SOCKET SET Many New Features Combined to Give Mechanics Most Value For Their Tool Dollars!

Snap-on scores again with a new "Master Supreme" set of four handles, three extensions, a universal joint, and fifteen popular sized sockets. In this ½" sq. drive set you will find highly engineered design, accurate balance, perfect fit, and a comfortable grip, that results in faster, safer, more satisfactory work. Every tool has a full chrome finish for long service life.

Check the features at the left, then ask the Snap-on man to show this set to you. Ask him to demonstrate — try the feel of the tools yourself. You'll agree that mechanics who use dependable tools like these will be a definite asset to your shop.

Over 4000 Snap-on tools are available through 41 direct factory branches located in key industrial areas.

*Snap-on is the trademark of Snap-on Tools Corporation

SNAP-ON TOOLS CORPORATION
8034-E-28TH AVENUE
KENOSHA, WISCONSIN

gram in bringing a closer measure of cooperation between education and industry. The whole-hearted participation of industry, on the other hand, shows an appreciation of this important phase of good Public Relations. The net result is far reaching benefits to the diesel industry as a whole.

Microfilm Agreement

Diesel Power & Diesel Transportation has entered into an agreement with University Microfilms, Ann Arbor, Michigan, to make available to libraries and other institutions, copies of its issues in microfilm form.

Microfilm is providing the solution to one of the most pressing problems facing libraries today—providing space for storage. Microfilm makes it possible to produce and distribute copies of periodical literature on the basis of the entire volume in a single roll, in editions of 30 or more, at a low cost.

Inquiries concerning the purchase should be directed to University Microfilms, 313 N. First St., Ann Arbor, Mich.

Stress Analysis Meeting

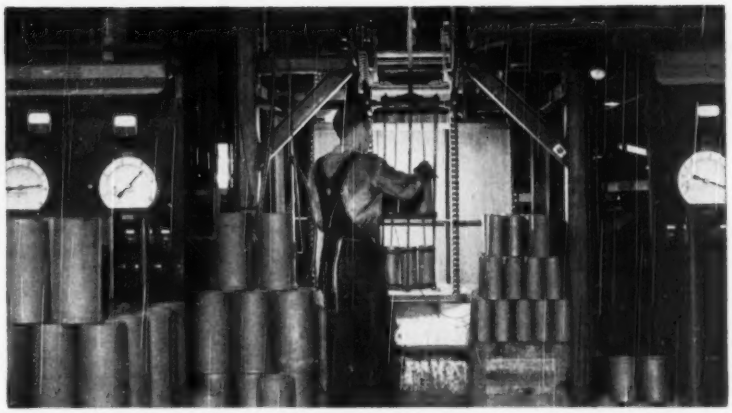
The Spring Meeting of the Society for Experimental Stress Analysis will be held at the Hotel Statler, Cleveland, May 25th to 27th. Inquiries concerning the meeting should be addressed to the Society for Experimental Stress Analysis, P.O. Box 168, Cambridge 39, Mass.

Alco Shift

In a move designed to improve service to its diesel engine customers, American Locomotive Company diesel engine sales and repair parts departments have been transferred from Auburn, New York to Schenectady, New York, effective immediately, according to a company announcement.

Customers have been notified that all communications relating to Alco or McIntosh and Seymour Marine and Stationary Diesel Engines and Parts should be addressed to Sales Department or Renewal Parts Departments, American Locomotive Company, Schenectady, New York.

Centrifugal found a way...



. . . TO CUT YOUR SLEEVE COSTS — *YET INCREASE SLEEVE LIFE AND PERFORMANCE!*

Specify

Centralloy

Ten alloys — for sleeves and piston rings. Castings rough machined to specifications. Write for "Revolutionary Results" and/or sample castings.

Yes, at low cost here's a sleeve of high physical properties that mean oil economy, prolonged engine life, higher compression and lower maintenance cost to your engine. Result of Centrifugal's patented, heat treatment process and special closely controlled composition. In addition to low original cost, other savings result because castings are free from primary cementite or objectionable free ferrite; are easily machined to steel-like finish free from hard spots and distortion; are low in scrap losses (as low as 1.5%). No wonder more and more of the nation's leading engine builders are specifying Centralloy.

CENTRIFUGAL FOUNDRY COMPANY
MUSKEGON, MICHIGAN
Centrifugally cast electric alloys — heat-treated by patented process for Super Duty.

F-M Pensions

A company-wide pension plan, which provides $100 a month minimum, for the more than 8000 employes of Fairbanks, Morse & Co. has been approved by the Directors, it was announced recently by Robert H. Morse, Jr..

"The plan will be offered immediately to the office and sales personnel, when the necessary government approval is granted. As many of the employes are represented by unions, the retirement plan for them will be worked out through the collective bargaining process, based on 30 years of continuous service," Mr. Morse said.

"The plan guarantees a minimum of retirement income of $100 a month, after 30 years of continuous service with the company, including social security. It will be entirely financed by the company. In general retirements above the minimum and for service less than 30 years will be computed under the formula which utilizes a percentage of wages earned and the number of years worked," Mr. Morse also stated.

Organizational News

Fairbanks-Morse President

The third generation Morse became President of Fairbanks, Morse & Co., on March 22, 1950.

Robert H. Morse, Jr., who started with the company in 1916 in the foundry of the Beloit, Wisc., plant, was elected to the Presidency by the Directors, following the annual meeting of stockholders.

Mr. Morse has been Vice President in Charge of Operations. Previously he was Vice President in Charge of Sales, Assistant General Sales Manager and has held many other positions.

His father, Colonel Robert H. Morse, whom he succeeded, becomes Chairman of the Board. Colonel Morse has been President since 1931 and has spent 55 years with the company. He also started in the Beloit Plant.

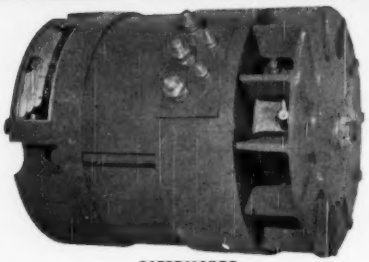
His Grandfather, Charles Hosmer Morse, was the founder of the company and was Chairman of the Board until his death in 1921. It was in 1847 when he bound himself out for $50 a year to learn the scale business with the firm which later became the present company.

Mr. Morse is also President of the Diesel Engine Manufacturers Association.

Johns-Manville Vice-President

Appointment of Phillip D. Cannon of Bound Brook, New Jersey, as Vice President of Johns-Manville Products Corporation and Production Manager of the Industrial Products Division,

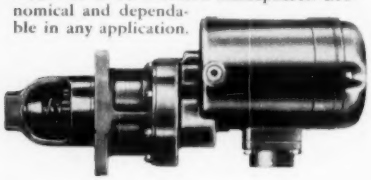
AC-DC GENERATING SYSTEMS



ALTERNATOR
(System includes Alternator, Rectifier, Regulator)
14 Volt Systems - - - - 60, 80, 100, 150 Amperes
7 Volt Systems - - - - 50 to 80 Amperes
24 and 32 Volt Systems available soon

AIR CRANKING MOTORS

AIR CRANKING MOTORS—For *safe* starting of Diesel engines in presence of flammable matter or in combustible atmospheres. Economical and dependable in any application.



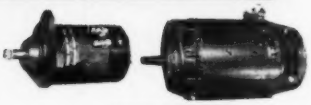
Choose from this QUALITY Line of

DIESEL ELECTRICAL EQUIPMENT

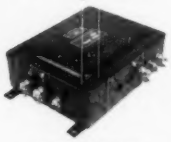
by Leece-Neville

D.C. ELECTRICAL SYSTEMS

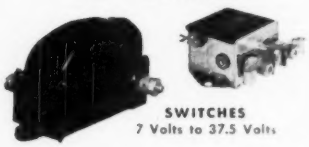
MOTORS
½ H. P. to 27 H. P.



GENERATORS
60 Watts to 2000 Watts



REGULATORS
7 Volts to 37.5 Volts



SWITCHES
7 Volts to 37.5 Volts

LEECE-NEVILLE
Pioneer and STILL Quality Leader

has been announced by J. A. O'Brien, Vice President and General Manager of the Division which operates 11 plants throughout the United States.

Mr. Cannon, formerly Manager of the company's Industrial Products plant at Manville, N. J., succeeds Alexander Cromwell who resigned recently to accept a position with a steel fabricating company.

Mr. Cannon's responsibilities will include production supervision over Johns-Manville industrial products at Billerica, Massachusetts; Nashua and Tilton, New Hampshire; Manville and New Brunswick, New Jersey; Marrero, Louisiana; Redwood City and Watson, California; Richmond, Indiana; Waukegan, Illinois, and Zelienople, Pennsylvania.

Worthington Eastern Manager

The appointment of A. M. Boehm as Eastern Manager, Engine Division has been announced by John J. Summersby, Vice President in charge of sales, Worthington Pump and Machinery Corporation. Mr. Boehm will handle sales negotiations for gas and oil pipe lines equipment and oil and gas engines for all services, and will continue to make the Corporation's New York District Office his headquarters.

Mr. Boehm has served Worthington for twenty-five years as an engine sales specialist assigned to various District Offices throughout the country. He succeeds W. L. Russell who has been assigned to handle Canadian sales for the John Inglis Company, Worthington's Canadian Associate.

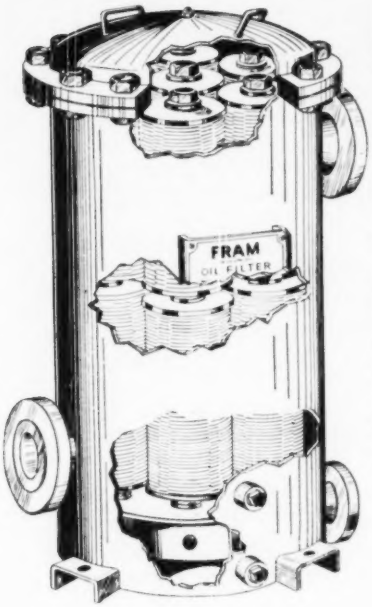
SAE Diesel Chairman

Jack A. Nelson of Chicago, diesel engineer with Standard Oil Company (Indiana), has been appointed general chairman for the national diesel engine meeting of the Society of Automotive Engineers, Inc., at the Hotel Knickerbocker in Chicago November 2 and 3, 1950.

Mr. Nelson joined Standard Oil Company (Indiana) in 1937 as an automotive engineer in the Des Moines, Iowa, sales field and in 1942 became a diesel engineer in the sales technical service department of the general office at Chicago. He has attended Standard's sales engineering school as well as a number of engine manufacturers' service schools.

Author of "Industrial Diesel Engines" and several other papers on diesel lubrication, Mr. Nelson has done pioneer work in the use of heavy-duty type oils in large industrial diesel engines.

FRAM FILTERS *Cut Costs...*



Extend Overhaul Periods

Read this 3 year performance record . . .

AT Springfield Bronze and Aluminum Co., Springfield, Mass., overhauls used to be required every 8000 hours on their 100 h.p. Diesel generator. Today, under the same grueling 24-hour running conditions, Fram Filters have extended overhauls to 20,000 hours.

GOOD CONDITION

Previous overhauls showed piston rings in poor condition, all at least partially frozen. Lube oil was black, dirty, laden with contaminants. Since installing Fram, the last overhaul was made after 833 days of continuous operation. The general condition of the engine was very good with "blow-by" at a minimum.

CUTS LUBE COSTS

The company calculated that the average cost of keeping lube oil clean to a .01 naphtha insolubles standard is 2 cents per hour, with oil change periods of 1000 hours compared to oil changes every 200 hours as previously required.

WRITE TODAY . . . Let Fram's Research Department help you determine how Fram Filcron Filters can give you lower operating costs and increased efficiency. You're sure of top performance because Fram Filters are *unconditionally guaranteed*. Write the Fram Corporation, Providence 16, R. I. *In Canada:* J. C. Adams Co., Ltd., Toronto, Ontario.

FRAM *Filcron*

THE MODERN OIL FILTER

Link-Belt VP

Link-Belt Company announces that Mr. David E. Davidson has been elected vice-president for sales, with headquarters at executive offices, 307 N. Michigan Ave., Chicago (1). All officers who served last year were re-elected.

Mr. Davidson, a mechanical engineering graduate of Armour Institute of Technology (now I. I. T.), has been general manager at the company's Pershing Road plant, Chicago, since 1947. He entered the employ of the company's Caldwell plant, Chicago, in 1924 in the shop.

Announcement is also made that Mr. Eugene P. Berg, formerly assistant general manager, has been appointed general manager of the Pershing Road plant, to succeed Mr. Davidson.

Mr. Berg, a mechanical engineering graduate of Purdue, began his Link-Belt career by working in the Pershing Road shop during vacations, 1929 to 1937.

Perfect Circle Changes

In a recent announcement made by Perfect Circle Corporation, it was revealed that Norman Rothenheber had been promoted to the position of Regional Manager in Region I, with headquarters in Philadelphia. He is filling the vacancy created by the death of Harry Walters last fall.

Since the first of this year, Norman has been Assistant Regional Manager in that region. Previous to that he had served as Manager in the St. Louis territory since he started with the Corporation in 1937.

Cliff Storey, Perfect Circle's District Manager in the Albany, New York area, has been selected for a new assignment and transferred to the Corporation's main offices in Hagerstown, Indiana. He has been with Perfect Circle since 1941, and has been in the New York territory since 1945.

In his new assignment Storey will handle sales promotion of the Nurlizer, Bearing Adjusters, Plastigage, and Manulathe in addition to other duties.

Alco Appointment

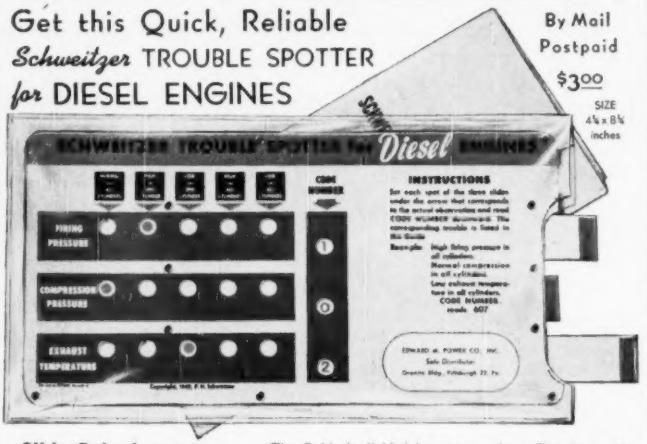
Duncan W. Fraser, chairman and president of the American Locomotive Company, announced today that Erskine W. Manterfield has been appointed director of public relations and advertising for the company. Mr. Manterfield will replace Holmes Brown, who has resigned to accept appointment on the staff of Colonial Williamsburg, Incorporated, the organization formed by John D. Rockefeller, Jr. to carry forward the restoration of Williamsburg, Virginia.

A graduate of the University of Pittsburgh, Mr. Manterfield was associated with Pennsylvania-Central Airlines (now Capital Airlines) from 1937 to 1942, and became assistant director of public relations for that company. After serving four years in the Army, he joined American Locomotive in 1946. He has been in charge of the company's public relations activities for the Alco Products and Railway Steel Spring Divisions, as well as for Alco's Canadian affiliate, Montreal Locomotive Works, Limited.

Get this Quick, Reliable
Schweitzer TROUBLE SPOTTER
for DIESEL ENGINES

By Mail
Postpaid
$3.00

SIZE
4¼ x 8¾
inches



Slide Rule Accuracy

This guide prepared by Paul H. Schweitzer, Dr. Eng. Penna. State College in collaboration with Diesel Engine experts enables operators and service men to locate and remedy troubles encountered in Diesel engine operation. Makes trouble spotting an easy semi-automatic process, and points unerringly to the proper remedy, thus saving a great amount of time and expense. The guide is snugly encased in stout plastic jacket.

The Guide is divided into two sections. The first section is entitled TROUBLE and it lists the code numbers for various observations, each with the corresponding trouble or troubles.

The second section is entitled DEFECTS and it deals with the origin of the various troubles.

The two sections are interlocked through a unique numbering system, which makes the use of the Guide extremely convenient.

The TROUBLE section carries code numbers in the left side column. These numerals correspond to those of the Trouble Spotter, attached to this booklet.

The second column lists suplementary observations which help to diagnose the trouble or to select the correct one if one code number allows more than one.

The third column lists the probable troubles corresponding to their code numbers.

Edward M. Power Co., Inc., 601 Granite Bldg., Pittsburgh 22, Pa.

Consult ELLWOOD
on all Your Small
Forging Requirements

Quality Precision Crankshafts For Diesels — Since 1910 . . .

ELLWOOD CITY FORGE COMPANY
CRANKSHAFTS - CONNECTING RODS
MACHINE FORGINGS
ELLWOOD CITY, PENNA.

Exide Appointments

Two new appointments have been announced by The Electric Storage Battery Company. Leland A. Wells has been appointed chief engineer of the firm and John B. Clark is the new Export Sales manager.

Mr. Wells has been connected with the battery industry for 30 years with the Willard Storage Battery Company where, for the past twelve years, he was chief engineer. He received his engineering education in the Case School of Applied Science and is a member of the SAE, Association of American Battery Manufacturers, the American Ordnance Association and the Armed Forces Communications Association.

Mr. Clark has been associated with the firm since 1929 and has wide experience in the industrial truck and locomotive battery fields. A graduate of Deerfield Academy, he received his college degree from CCNY where he majored in foreign trade and economics.

Nordberg Sales Manager

The appointment of Jos. G. Broz as sales manager of the Four Cycle Diesel Engine Dept. is announced by R. W. Bayerlein, vice-president of the Heavy Machinery Division, Nordberg Manufacturing Co.

Mr. Broz was vice-president in charge of sales of Busch-Sulzer Diesel Engine Company of St. Louis, Mo. at the time that company was purchased by Nordberg in December, 1946. Until his present appointment Broz was surveying South American market potentialities and establishing field sales and service organizations there for Nordberg.

Prior to his association with Busch-Sulzer, Broz was with Baldwin Locomotive Works from 1930 to 1944. He was manager in charge of sales and service of diesel, electric and mine locomotives and diesel engines at Baldwin and also sales manager and director of Baldwin-De La Vergne Sales Corp.

Mr. H. M. Cahill will assist Broz in directing the sales activities of Nordberg's Four Cycle Diesel Engine Dept.

Specify

COLUMBIA

A. C. and D. C.
GENERATORS

- For Coupled Service
- For Belt Drive
- Single or Two Bearing

Columbia, with its years of experience, brings to generator set assemblers a wide line of performance proved, sturdily built, A. C. and D. C. Generators.

AC Generators: 6¼ to 1000 KVA
DC Generators and Exciters: 2 to 300 KW

•

Write for information. Our Engineers will be glad to review your requirements.

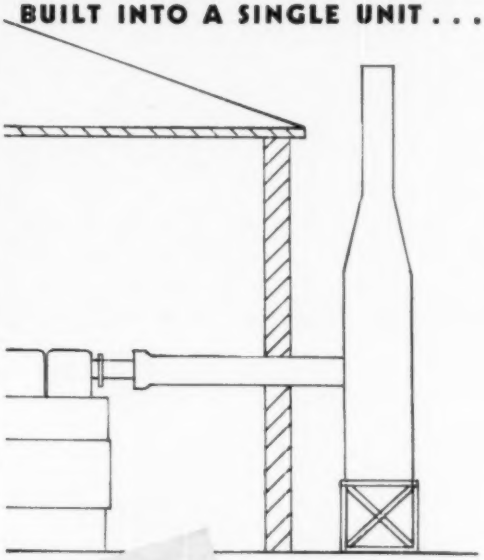
COLUMBIA ELECTRIC MFG. CO.
4537 Hamilton Ave. Cleveland 14, Ohio

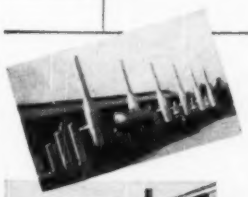
SURE CURE FOR PUMP HEADACHES

Forget pump worries. Tuthill small pumps are recognized the world over for their dependability in lubrication, coolant, hydraulic and liquid transfer service. These internal-gear type rotary pumps are available in capacities up to 200 g.p.m. and pressures up to 400 p.s.i. Wide choice of porting and mounting arrangements in both packed and mechanically sealed pumps. Write for General Catalog.

TUTHILL PUMP COMPANY
939 East 95th Street, Chicago 19, Illinois

ADEQUATE SILENCING
BUILT INTO A SINGLE UNIT . . .





A single silencer outside and only the exhaust piping inside — a space saving installation — and a flexible one because exhaust can be run high, low, or underground with the Maxim Air Induction Silencer. The inlet can be placed where you want it. Hot air is drawn out of the engine room, and piping and silencer are both cool so that paint will stay on. Investigate this *most practical* way to get adequate silencing and engine room ventilation.

SEND FOR BULLETIN

THE MAXIM SILENCER COMPANY

93 HOMESTEAD AVE. HARTFORD 1, CONNECTICUT
Please send AIR INDUCTION SILENCER bulletin.
NAME _____
COMPANY _____
ADDRESS _____

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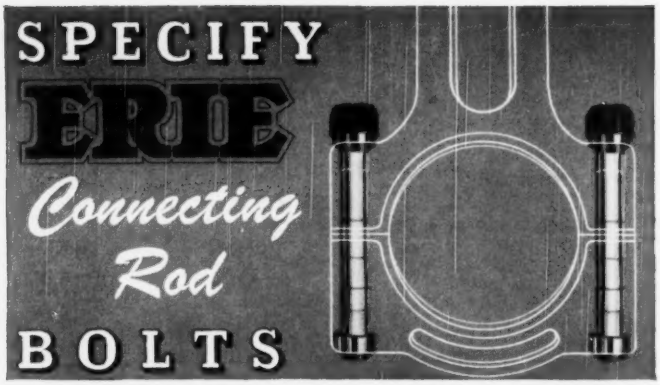

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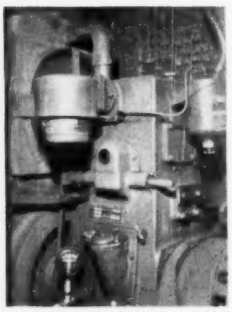

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Alco Appointment

Appointment of William G. Miller as executive assistant to the Chairman and President of American Locomotive Company was announced by Duncan W. Fraser, Chairman and President.

Since August, 1943, Mr. Miller has been Manager of the company's Auburn, N. Y. plant. He is succeeded at Auburn by Charles T. Lathrop, formerly Auburn Works Manager.

Obituaries

Herbert M. Kaufmann

Dr. Herbert M. Kaufmann, Chairman of the Board of Directors of Mutual Chemical Company of America, died March 20th, at his home after a short illness. He was in his eightieth year.

Born in Philadelphia in 1870, he graduated as a chemist at the age of eighteen from the University of Pennsylvania and then continued his studies abroad at the Swiss Polytech, Zurich, and obtained his doctorate in chemistry in 1891 from the University of Basle. He moved to New York in 1909.

In 1896, he joined the Mutual Chemical Company of Jersey City as chemist, superintendent and works manager. In 1903, that company which was then a major factor in the chromium chemical industry, and the American Chrome Company were merged to form the present Mutual Chemical Company of America. Dr. Kaufmann was its President from 1933 to 1943 and the Chairman of the Board of Directors since then. The company has plants in Baltimore and Jersey City and its executive offices in New York.

He was a member of the Advisory Committee of the 42nd Street Branch of the Chase National Bank and served as a Director of the Phosphate Mining Company up until the time that company was sold to Virginia Carolina Chemical Company. For many years he was a Trustee of the Free Synagogue and Treasurer of the Jewish Institute of Religion, both institutions founded by the late Dr. Stephen S. Wise. He was a member of the Harmonie and Chemists' Club.

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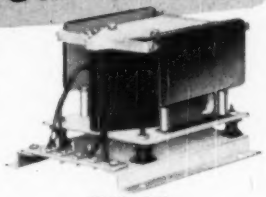

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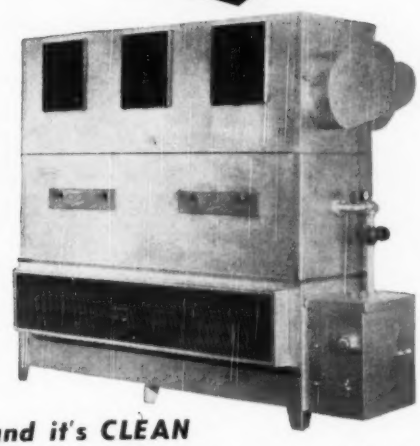

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Harold E. Parker

Services were held Mar. 28 for Harold E. Parker, manager of Eastern Region industrial sales in the marketing division, Socony-Vacuum Oil Company, Inc., who died suddenly Mar. 26. He was 52 years of age.

A native of San Francisco, Mr. Parker travelled over the world as a marine engineer. Later he was a testing engineer for marine equipment. He started with Socony-Vacuum in 1928 in industrial marketing in the New England Division and was transferred to the company's headquarters, 26 Broadway, in 1945.

Mr. Parker leaves his wife, Mrs. Josephine Parker; three daughters, Helen, Janet and Beverly, his mother; and a brother and a sister. The mother, brother and sister live in California.

Mitsubishi Engine

(*Continued from page* 57)

materially reduce the weight. The housings on all of the water and lubricating oil pumps could be reduced in weight by using lighter, more completely machined, castings. The cast iron exhaust manifolds could be fabricated from sheet steel to reduce the weight of the units. The cases, manifolding, and mounting brackets of all the lubricating oil and fuel oil strainers are unnecessarily heavy and the fresh water and lubricating oil cooler assemblies are heavy and appear to be larger in size than necessary.

Unsatisfactory Features

Thus far, this article has been highly favorable to the Japanese design, describing those parts of the engine which appear to be better than current American practice while ignoring the shortcomings of the engine. This has been done because it is felt that no useful purpose would be served by describing in great detail parts of the Japanese engine which were below American standards. However, there were several shortcomings in the engine which bear brief mention, if only for the record.

Those details of design less satisfactory than American practice included lack of positive location of the cylinder head on the block, permitting the piston edge to contact the edge of the recess in the head; an unnecessarily complex valve operating mechanism; maximum and idling speed control only on the governor; fuel injector linkage slips; the cylinder head gasket permitted gas, oil or water leakage; an unnecessarily complicated fuel system; inadequate fuel and lube oil filtering; poor cooler construction; non-rigid housings for the starting air check valves; and general lack of accessibility for removal of main bearings, pistons and connecting rods.

Another consideration which does not speak well for the manufacturers is that the workmanship was inferior to good American practice as indicated by variations in clearances of working parts, by improper assembly which made some controls partially or totally

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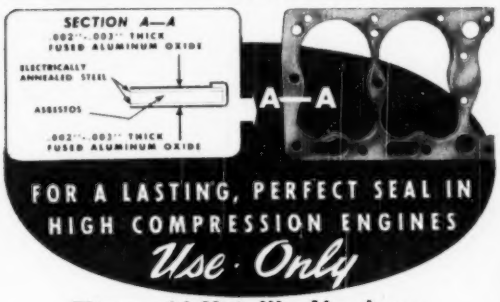

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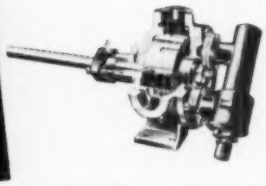

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inoperative, and by variation in fuel injection timing and quantity injected with a given rack setting and plunger travel of the fuel injectors.

Conclusion

Because the tests on the engine are yet to be completed, it is impossible at this time to state definitely whether or not the engine is, on the whole, superior or inferior to comparable American engines. It does appear, however, that the manufacturers, Mitsubishi-Tokyo, have incorporated features in their design which are superior to normal American practice and other features are present which are definitely inferior to American practice.

The most noteworthy aspect of the engine is its very low ratio of weight to horsepower. This is a very definite advantage and would appear to indicate that the Japanese, at least in this respect, are very much ahead of American designers in this one category. When the complete report is released, the editors will endeavor to present it to the readers of *Diesel Power and Diesel Transportation* so that the engine can be completely evaluated and compared in all respects to our modern American engines.

Diesel Motor Trains

(*Continued from page 37*)

runs of 200 miles or less. On such short runs, the traffic volume frequently does not justify the use of locomotive-propelled trains, but in many cases is more than sufficient to support economical diesel motor train service.

For maximum utilization, it is essential that the diesel motor train be designed to meet the widest variety of requirements. It must satisfy suburban and mainline requirements; it must likewise accommodate itself to small and large traffic requirements. It should operate equally well in either direction and it should not require turning around or switching. It must be of optimum economical size — neither too small to cover its crew expense and other operating costs nor too large to be economical for small traffic volume.

Technological developments within the past few years make possible motor trains of greater speed, flexibility, riding comfort and economy. Recently developed "package" diesel power plants simplify maintenance and increase availability. Multiple-unit controls afford flexible capacity to meet changes in demand, as any number of motor cars and trailers can be operated by a single motorman. Automatic electric couplings controlled by push-button from the driver's cab facilitate rapid assembly and disassembly of multiple-unit trains. Recently devel-

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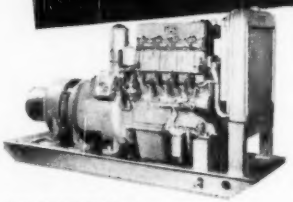

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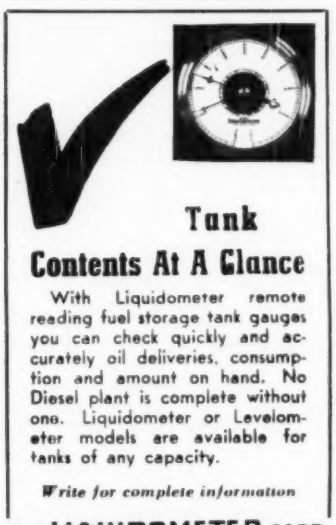
oped hydraulic and mechanical transmissions for railroad diesel engines offer the possibility of still greater economy and efficiency than the popular electric transmission equipment. Greater structural strength accompanied by lighter weight materials presents another challenging opportunity in the design of the motor train.

The articulated 3-car design (three cars mounted on four trucks) has been highly satisfactory both in Europe and in the United States. It has shown high availability and economy through its simplicity of construction. Moreover, with two out of every four trucks powered, as in the Netherlands design, a rate of acceleration similar to that of multiple-unit electric trains can be achieved.

The diesel motor train, being designed for maximum economy and versatility, can likewise provide flexible and economical merchandise freight service. Motor trains may be adapted to various types of traffic—passengers, mail, express or freight—simply by variation of interiors and floor plans.

Train-side bus connection service with closely coordinated schedules greatly increases the ability of railroads and bus lines to meet the competition of private automobiles. In the few instances where such coordination has been employed it has proved highly successful. However, the surface has only been scratched in the exploitation of this technique. The full profitability of diesel motor trains cannot be realized until this practice is adopted in connection with suburban and main-line operations.

The isolation of remote airports at the outskirts of cities in many cases can be reduced by the use of connecting diesel motor trains which, being economical to operate, can provide frequent low-cost service. Likewise, motor train schedules may well be coordinated with water services at various points on the seacoast and at inland ports.



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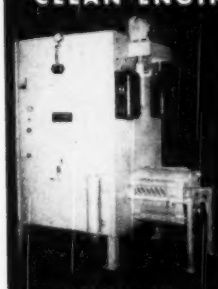

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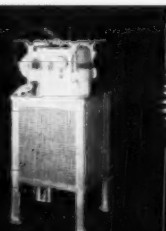

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May, 1950

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Zallea Expansion Joint News

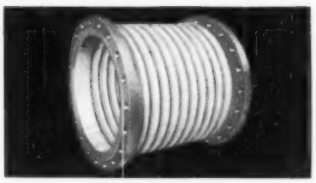
PUBLISHED BY ZALLEA BROTHERS—WORLD'S LARGEST MANUFACTURERS OF EXPANSION JOINTS EXCLUSIVELY

Expansion Joint of the Month

Why Zallea Joints Last Longer

CHOSEN FOR PERFORMANCE

Tremendous stamina is a must in flexible connectors for modern diesels . . . and ZALLEA Flexible Connectors "have what it takes". That's why more engineers choose ZALLEA over any other make. Construction is simplified . . . flexibility has been achieved at no sacrifice of durability . . . maintenance is eliminated . . . no seams or joints to open. And ZALLEA Flexible Connectors, engineered with annular corrugations, eliminate torsional strains so common to spiral or helical types of connectors. Because



of their great axial and lateral movement, bends may be made to a minimum radius of as little as $1\frac{1}{2}$ times the diameter. ZALLEA Flexible Connectors are available in diameters from 4" to 72" with flanged or welding ends or a combination of both. Made of stainless steel to handle exhaust temperatures up to 1600° F.

. . . a complete, practical catalog on all Zallea Expansion Joints. A text book and a valuable reference source. Send for your *free* copy *today!*

ZALLEA BROTHERS, 812 Locust Street
Wilmington 99, Delaware

CONTROLLED WELDING ASSURES LONGER EXPANSION JOINT LIFE

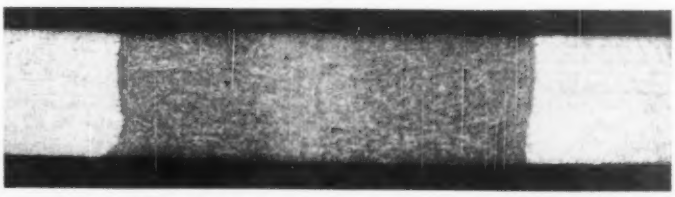
In a corrugated expansion joint, the deflection stress varies directly as the bellows thickness. And, the life of a corrugated expansion joint varies as the cube of the bellows thickness. Therefore it is essential that the corrugated bellows have a uniform thickness throughout. Only in Zallea Stainless Steel Expansion Joints are you assured of this optimum condition because Zallea alone produces a longitudinal weld of the same thickness as the parent metal.

Welding Methods Tested

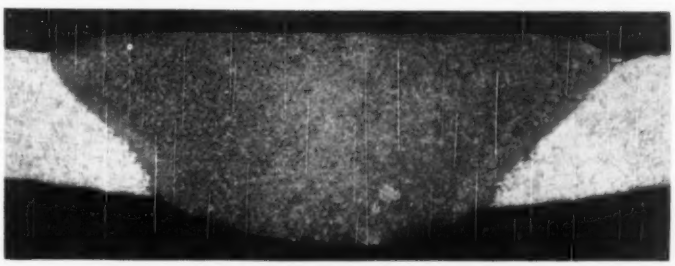
Accelerated flexing tests of corrugated bellows proved that the resultant welding bead of a shielded arc weld was detrimental to the life of the bellows because failure always occurred across the weld —thickest section of the bellows. Zallea metallurgists, after analyzing the many known welding processes, found that by adopting an exclusive variation of the Heliarc process and adding a grain refining procedure to the finished weld, they could produce a corrugated bellows that under accelerated flexing tests *failed in the parent metal only.*

Longer Life Assured

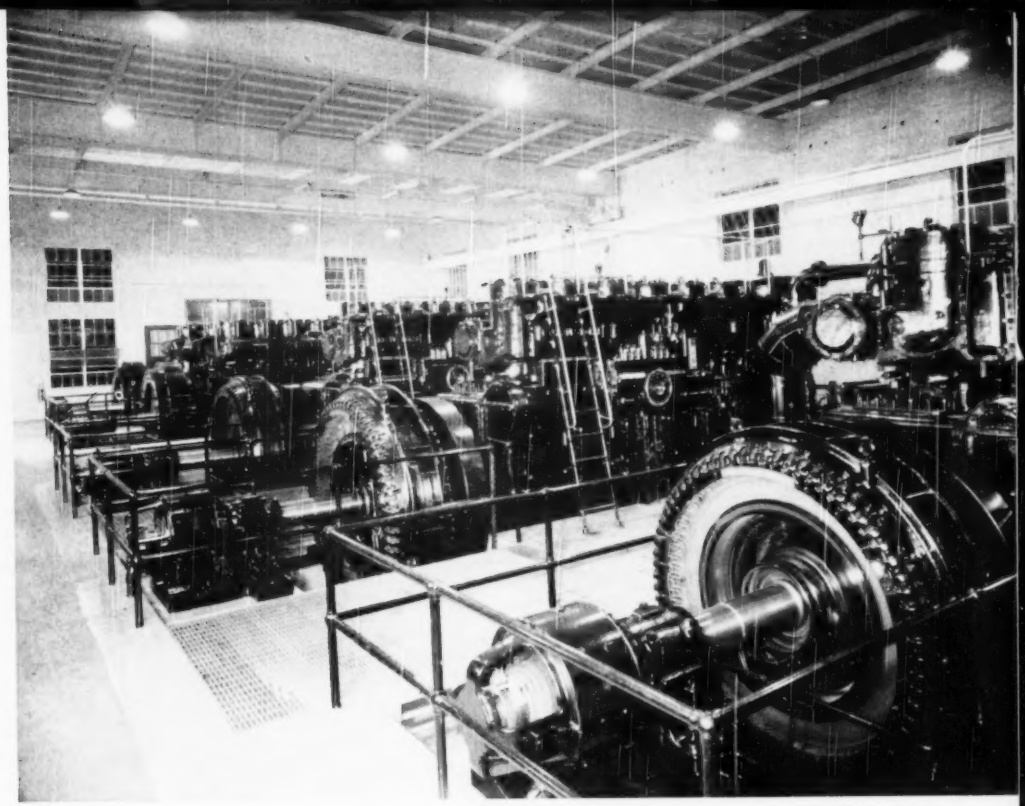
In over 100 bellows tested with Zallea *controlled* welding, not one failure occurred within 50 degrees of the weld line. More important was the fact that these bellows lasted four to eight times longer than bellows having a shielded arc welding bead. The two untouched photomacrographs below illustrate the exclusive Zallea *controlled* welding technique as compared to the welding procedure used in other expansion joints. When you want the best in stainless steel expansion joints, always specify ZALLEA . . . you'll find it pays!



Weld bead of Zallea Expansion Joints *(Compare fine grain of weld with illustration below)*



Weld bead of competitive expansion joint



NO lubricant change in 40,000 hours!

● A 10-cylinder 2,000-HP Fairbanks-Morse Diesel at the City of Jacksonville, Illinois, municipal power plant has required no change of its lubricant in over 40,000 hours of operation on STANDARD HD Diesel Oil. In all of this time, STANDARD HD has shown practically no deterioration. The engine crankcase has remained entirely free from deposits.

The piston rings in this same engine were in operation for 14,206 hours, and on inspection revealed not one broken or stuck ring. There was so little wear of the rings that, in most cases, the original tool marks were clearly visible.

Such lubricating efficiency is especially significant when the size of the Jacksonville plant is considered. Five F-M units, totaling 6,975 horsepower, a new 2,000-HP unit having been recently installed, make this plant one of the largest Diesel installations in Illinois. STANDARD HD in all units has helped keep maintenance costs at a rock-bottom low.

The experience of the Jacksonville plant indicates the savings you can expect to make by using STANDARD HD Diesel Oil. This truly heavy-duty lubricant owes its superiority to the combination of effective oxidation-resistant and detergent additives with solvent-extracted base stocks of highest quality. A Standard Oil Lubrication Engineer will help you obtain the best possible economy.

Write Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago 80, Illinois.

Standard HD
DIESEL OIL

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